

UNIVERSITY OF ARIZONA



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THE BOTANY OF ICELAND

EDITED

BY

L. KOLDERUP ROSENVINGE

PH. D.

AND

EUG. WARMING

PH. D., SC. D.

VOL. I

WITH ONE PLATE AND 82 FIGURES IN THE TEXT

COPENHAGEN
J. FRIMODT

LONDON
JOHN WHELDON & CO.
1912-1918

PUBLISHED BY THE AID OF THE CARLSBERG FUND



H. H. THIELES BOGTRYKKERI, KØBENHAVN

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1. THE MARINE ALGAL VEGETATION BY HELGI JÓNSSON, PH. D.

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PREFACE.

IT was mentioned in the preface to the "Botany of the Færøes" (Copenhagen & London, 1901—1908) that, on the completion of that work, Iceland would be the one island among the dependencies of the Danish kingdom in the Atlantic which was in most need of a thorough and systematic investigation as regards its botany, and the hope was expressed that this would be commenced as early as the year 1909. This hope has been so far realized that we, the undersigned, are now able to publish the first paper on the subject, viz. "The Marine Algal Vegetation" by Dr. HELGI JÓNSSON of Reykjavík. Iceland, however, is so large compared with the Færøes that the investigation will not only be far more difficult to carry out, but will also extend over a far longer period.

We hope that specialists in botany may be able, at short intervals, to visit the island and make collections and notes. Thus, even in 1910 a young bryologist, A. HESSELBO, studied the moss-vegetation — when he took the photographs, published in the present paper — and this summer he is again paying a visit to the island, after which he will prepare an account of the moss-flora and the moss-vegetation of Iceland.

Next summer we hope that a young lichenologist will be able to set to work in a similar manner, and will be followed by others, until the work can be completed with a general account of the vegetation and the plant-geographical position of the island.

L. KOLDERUP ROSENVINGE.

EUG. WARMING.

COPENHAGEN, AUG. 1912.

1.

THE MARINE ALGAL VEGETATION OF ICELAND

BY

HELGI JÓNSSON

PH. D.

WITH 7 FIGURES IN THE TEXT

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INTRODUCTION.

IT is far from being a fact that the Marine Algal Flora and Marine Algal Vegetation of Iceland can be regarded as sufficiently known; this does not apply in the same degree, however, to all parts of the coast. East Iceland, South Iceland and South-west Iceland are better known in this respect than North-west Iceland and North Iceland. Also, as is very natural, the littoral vegetation is better known than the sublittoral, as it is easier of access and may be investigated directly on the spot, while, as regards the sublittoral vegetation, one has to be content with what is obtained from dredgings.

Very little has previously been written with regard to the marine algal vegetation of Iceland. Strömfelt, who travelled in Iceland in the summer of 1883, has treated the algal flora exhaustively (see Jónsson, 31) in his valuable work "Om Algevegetationen vid Islands kuster" (70) and has given a critical review of the older literature of the marine algal flora of Iceland; but, on the other hand, he has dealt very briefly with the marine algal vegetation. He follows Kjellman in dividing the vegetation in question into a littoral and a sublittoral vegetation. Strömfelt found the littoral vegetation poorly developed in many places — he records, however, a luxuriant littoral vegetation from Reykjavík, Eyrarbakki and Eskifjörður. The sublittoral vegetation is mentioned even more briefly, and is emphasized as being more uniform than the littoral as regards its distribution and the species which compose it. Strömfelt does not make any definite statement regarding the elittoral vegetation, owing to his not having dredged in sufficiently deep water, but he considers it improbable that any vegetation worthy of notice occurs at that depth, as he did not find any rich vegetation at a greater depth than 10—12 fathoms.

The reason why Strömfelt found the littoral vegetation on the north coast so poorly developed may be two-fold: it may result

from the drift-ice having remained at the coast during the whole summer of the previous year (1882), but it may also be due to the fact that, in this case, Strömfelt went by steamer from port to port, and could scarcely have obtained a thorough knowledge of the coast in as much as the steamer usually stops only a short time at each port.

Strömfelt mentions the following algal formations: the *Fucaceæ*-formation which is reported from Hólmanes and Seley in E. Iceland; the *Laminaria*-formation, under which a subvegetation of red algæ is mentioned. Further, a *Monostroma*-vegetation is recorded as occurring near Ekifjörður at a depth of two fathoms on a sandy bottom, and a *Halosaccion*-formation at extreme low-water mark on Hólmanes. Strömfelt expresses the opinion, moreover, that a *Corallina*-formation formed by *Lithothamnion*-species must exist, but he does not say anything definite regarding this point, as he received almost all the *Lithothamnion*-species from the fishermen (70, pp. 10, 11). The description of the vegetation is evidently based on observations made in places where Strömfelt stayed for a longer time, viz. Eskifjörður and Reyðarfjörður in E. Iceland, and Eyrarbakki in S. Iceland. I have incorporated Strömfelt's observations with my own in my description of the vegetation.

Strömfelt, on the other hand, treats exhaustively of the distribution of the species along the coasts. Thus he is the first to substantiate the existence of two floral districts in the sea on the coasts of Iceland: a cold-water flora in NE. Iceland and a warm-water flora in SW. Iceland. In a table he gives a summary of the distribution of the species along the coast of Iceland, and states whether they are found in the Norwegian Polar Sea, the North Atlantic and the Greenland Sea. He records 33 species as common to NE. Iceland and SW. Iceland, 33 species as growing in NE. Iceland and absent from SW. Iceland, and 28 species as growing in the latter district and absent from the former. Thus 66 species in all are recorded from NE. Iceland and 61 species from SW. Iceland. Of the species given by Strömfelt as being found in or absent from NE. Iceland and SW. Iceland respectively, later investigations have proved that far the greater number are common to both places, but then, again, other species have been found which are characteristic of the different districts.

My description of the algal vegetation along the coast of Iceland is based mainly on my own observations, and further on

Strömfelt's work, as well as on Ostenfeld's observations. The latter mainly concern the littoral zone, and originate from E. Iceland (Hólmanes), SW. Iceland (Reykjavík, Njarðvík) and S. Iceland (Staður on the south side of Reykjanes).

Ostenfeld, moreover, has given information of the sublittoral vegetation of Myrakollur in NW. Iceland.

My own observations are drawn from various places encircling the whole of Iceland. In E. Iceland I have especially investigated Berufjörður, Reyðarfjörður and Seyðisfjörður, and everything which is narrated of the algal vegetation from E. Iceland originates from these fjords. In N. Iceland I have examined Eyjafjörður fairly accurately, from its innermost part to the submarine ridge off Hrísey, and I have, moreover, in the course of my journey, investigated the head of Húnaflói. When travelling by the mail steamer "Laura" round NW. Iceland I visited all the fjords from Skutulsfjörður to Patreksfjörður. I stayed only a short time in each fjord, as I accompanied the boat from port to port, and was only able to dredge and investigate the littoral zone in the vicinity of the towns. In SW. Iceland I have been at the south side of Breiðifjörður, and have dredged along the stretch of coast from Röst in Hvammsfjörður to Hjallasandur, and have also examined the littoral zone over a far larger area, not only round Snæfellsnes but also in Dalasýsla. Round Reykjavík I have dredged and investigated the littoral zone many times. In S. Iceland I have investigated the Vestmannaeyjar most thoroughly and have, in addition, dredged and examined the littoral zone at Eyrarbakki. All remarks concerning the algal vegetation of S. Iceland are based on observations drawn from the western part of the south coast. The eastern part of the south coast from about Stokkseyri eastward is, as far as I know, a sandy coast, a "desert" devoid of algal vegetation. I have not dredged further east than round the Vestmannaeyjar, but on my trip through S. Iceland in 1901 I saw very few algæ cast ashore, which may be regarded as a sure sign that a desert lies beyond, because, where algal vegetation exists, it is quite common, with a landward wind, for large, often astonishingly large quantities of algæ to be thrown up on the shore. What might not be found then, on the south coast, where the swell of the Atlantic rolls up onto the flat shore, if any algal vegetation existed further out! Nor can it be expected that anything but a desert exists off this coast, as the bottom consists of sand, and the coast lies exposed to the sea, like the west coast of Jutland. Where, on the other hand, there

are rocks, there vegetation is sure to occur. At Vík in Myrdal near the southern point of Iceland there was, for instance, a poor vegetation on the rocks.

When one considers how great is the extent of Iceland's coastline, one cannot expect this to be sufficiently elucidated as regards the distribution of marine algæ by the few and scattered investigations which have been undertaken. For a long time, then, I nourished the hope of being able to undertake further investigations, and therefore constantly deferred publishing a comprehensive description of the algal vegetation. Now, however, I have decided to delay no longer and hope in the future to be able to make a more extensive contribution in several respects towards the elucidation of the algal vegetation.

I. LIST OF THE MARINE ALGÆ.

THE following List of the Marine Algæ of Iceland is extracted from my earlier publications (Jónsson, 31, Börgesen and Jónsson, 14) and from the paper by Henning Petersen (57) on the species of *Ceramium*. It gives only the names of the species with synonyms, their distribution in the different coastal districts and some new habitats. The limitation of species is unchanged except in the case of the genus *Ceramium* and in *Clathromorphum circumscriptum* (Strömf.) which is included in *Clathromorphum compactum* (Kjellm.) as proposed by Foslie. One species, *Vaucheria sphærospora* Nordst. (Börgesen and Jónsson, 14), is omitted from the list as it can scarcely be called a Marine Alga. Of *Ceramium* 5 species are added.

Thus the number of species is: —

76 Rhodophyceæ

67 Phæophyceæ

51 Chlorophyceæ

6 Cyanophyceæ

Total... 200 species.

The coastal districts are the following (see the map, p. 7): —

East Iceland (E. Icel.), from Lónsheiði (Eystra horn) to Langanes.

North Iceland (N. Icel.), from Langanes to Hornbjarg (Kap Nord).

Northwest Iceland (NW. Icel.), from Hornbjarg to Látrabjarg.

Southwest Iceland (SW. Icel.), Breiðifjörður and Faxaflói from Látrabjarg to Reykjanes.

South Iceland (S. Icel.) from Reykjanes to Vestmannaeyjar and eastwards to Lónsheiði (Eystra horn).

In "The Marine Algæ of Iceland" (Jónsson, 31) the district NW. Icel. is larger; it reaches from the inner end of Húnaflói to Látrabjarg instead of as now from Hornbjarg to Látrabjarg. Localities from the part of the coast which stretches from Húnaflói to Horn-

bjarg are referred to NW. Icel., in the paper mentioned above, but in the present work (cf. Jónsson, 33, p. 11) to North Iceland. These localities are: Hrútafjörður, Prestsbakki, Kolbeinsá, Skálholtsvík, Kollafjarðarnes, Broddanes and Grímsey in Húnaflói.

RHODOPHYCEÆ.

BANGIOIDEÆ.

Fam. **Bangiaceæ.**

Bangia fuscopurpurea (Dillw.) Lyngb., K. Rosenv., 61, p. 831.
E. Icel., N. Icel., SW. Icel., S. Icel.

Porphyra umbilicalis (L.) J. Ag., K. Rosenv., 61, p. 830; *P. laciniata* Strömf., 70, p. 34.

Common in all parts of the coast of Iceland.

Porphyra miniata (Ag.) Ag., K. Rosenv., 61, p. 826; *Diploderma* m., *D. tenuissimum*, *D. amplissimum* Strömf., 70, p. 33.

Found in all parts of the coast.

Porphyropsis coccinea (J. Ag.) K. Rosenv., 65, p. 69; *Porphyra coccinea* Jónsson, 31.

SW. Icel.: Reykjavík, S. Icel.

Conchocelis rosea Batters.

Found in all parts of the coast.

FLORIDEÆ.

Fam. **Helminthocladiaceæ.**

Chantransia virgatula (Harv.) Thur., K. Rosenv., 61, p. 824.
NW. Icel., SW. Icel.

Chantransia secundata (Lyngb.) Thur., K. Rosenv., 61, p. 824.
Found in all parts of the coast.

Chantransia Alariæ H. Jónsson, 31.
SW. Icel., S. Icel.: Eyrarbakki.

Chantransia microscopica (Naeg.) Fosl. On *Cladophora gracilis* in the littoral zone. Thallus has long hairs. Published in Börgesen and Jónsson, 14.

N. Icel.: Kolbeinsá.

The specimens mentioned under this name belong most probably to another species of *Chantransia* with a unicellular base.

Fam. **Gigartinaceæ.**

Chondrus crispus (L.) Stackh., Strömf., 70, p. 31.

NW. Icel. (cast ashore), SW. Icel., S. Icel.

Gigartina mamillosa (Good. et Wood.) J. Ag., Strömf., 70, p. 31.

Found in all parts of the coast, common in SW. Icel. and S. Icel.

Ahnfeltia plicata (Huds.) Fries, Strömf., 70, p. 31.

Cast ashore on N. Icel. and NW. Icel., common in SW. Icel. and S. Icel.



Fig. 1.

Phyllophora Brodiaei (Turn.) J. Ag. **interrupta* (Grev.) K. Rosenv., 61, p. 821.

E. Icel., NW. Icel.

Phyllophora membranifolia (Good. et Wood.) J. Ag., Strömf., 70, p. 30.

SW. Icel., S. Icel.

Actinococcus subcutaneus (Lyngh.) K. Rosenv., 61, p. 822.

E. Icel., NW. Icel.

Ceratocolax Hartzii K. Rosenv., 62, p. 34.

NW. Icel.

Fam. **Rhodophyllidaceæ.**

Cystoclonium purpurascens (Huds.) Kütz., Strömf., 70, p. 30.

N. Icel., NW. Icel. (cast ashore), common in SW. Icel. and S. Icel.

Turnerella Pennyi (Harv.) Schmitz, K. Rosenv., 62, p. 29.
E. Icel., N. Icel.

Euthora cristata (L.) J. Ag., Strömf., 70, p. 27.
Common around the coast of Iceland.

Rhodophyllis dichotoma (Lepech.) Gobi, Strömf., 70, p. 26.
Common around the coast of Iceland.

Fam. **Rhodymeniaceæ.**

Rhodymenia palmata (L.) Grev., Kjellman, 36, p. 147; Strömfelt, 70, p. 27; R. *pertusa* Strömf., 70, p. 28.
Very common around the coast of Iceland.

Lomentaria clavellosa (Turn.) Gaill.; Le Jol., Liste des Algues mar. de Cherb., p. 132, var. *sedifolia* Ag.
S. Icel.

Lomentaria rosea (Harv.) Thur., Le Jol., Liste des Alg. mar. de Cherb., p. 131, Fig. Harv. Phyc. Brit., T. 358 and 301.
S. Icel.

Plocamium coccineum (Huds.) Lyngb., Strömf., 70, p. 27.
S. Icel.

Halosaccion ramentaceum (L.) J. Ag., Kjellm., 36, p. 153; Strömf., 70, p. 29; H. *scopula* Strömf., 70.
Common around the coast of Iceland.

Fam. **Delesseriaceæ.**

Delesseria alata (Huds.) Lam., Strömf., 70, p. 24.
SW. Icel., S. Icel.

Delesseria Baerii (Post. et Rupr.) J. Ag.; **corymbosa* (J. Ag.) K. Rosenv., 61, p. 806.

There is a specimen of this plant in the herbarium of the Botanical Museum in Copenhagen; it is labelled "Islandia d. Mörck."

Delesseria sinuosa (Good. et Wood.) Lam., Strömf., 70, p. 24.
Common around Iceland.

Delesseria sanguinea (L.) Lam.; *Hydrolapathum* s. Strömf., 70, p. 26.
E. Icel.; rather common in SW. Icel. and S. Icel.

Fam. **Bonnemaisoniaceæ.**

Bonnemaisonia asparagoides (Wood.) C. Ag.

In the herbarium of the Botanical Museum in Copenhagen there are three specimens of this species, said to have been collected in Ice-

land. On one of the labels is written "misit Faber." In Flora Danica T. 2579 a specimen of this plant is figured, regarding which Liebmann writes: "ad littora Islandiæ pr. Reykjavik legit beatus Faber, cujus specimen mecum communicavit cl. Hofman-Bang."

Fam. **Rhodomelaceæ.**

Pterosiphonia parasitica (Huds.) Falkenberg, Die Rhodomelaceen des Golfes von Neapel. *Polysiphonia* p. Kjellman, 36, p. 117: H. Jónsson, 31, p. 142.

S. Icel.

Polysiphonia urceolata (Lightf.) Grev., Strömf., 70, p. 24.

Common around Iceland.

Polysiphonia fastigiata (Roth) Grev., Strömf., 70, p. 24.

NW. Iceland.; common in SW. Icel. and S. Icel.

Polysiphonia arctica J. Ag., K. Rosenv., 61, p. 800.

E. Icel., N. Icel. and NW. Icel. common; SW. Icel.

Polysiphonia nigrescens (Huds.) Harv., Kjellman, 36, p. 126.

N. Icel., SW. Icel.

Rhodomela lycopodioides (L.) Ag., Strömf., 70, p. 23.

Common around Iceland.

Odonthalia dentata (L.) Lyngb., Strömf., 70, p. 23.

Common around Iceland.

Fam. **Ceramiaceæ.**

Callithamnion Arbuscula (Dillw.) Lyngb., Strömf., 70, p. 32.

Rather common in SW. Icel. and S. Icel.

- **Callithamnion scopulorum** C. Ag., Spec. Alg. (2), p. 176.

SW. Icel., S. Icel.

Plumaria elegans (Bonnem.) Schmitz, Syst. Uebersicht der bisher bekannten Gattungen der Florideen, Flora oder allgem. bot. Zeit., 1889; *Ptilota* e. Kjellman, 36, p. 172.

SW. Icel., S. Icel.

Ptilota plumosa (L.) Ag., Strömf., 70, p. 32.

N. Icel.; common in NW. Icel., SW. Icel. and S. Icel.

Ptilota pectinata (Gunn.) Kjellm., Strömf., 70, p. 32.

Common in E. Icel., N. Icel. and NW. Icel.; rather rare in SW. Icel.

Antithamnion Plumula (Ellis) Thur. *β boreale* Gobi, K. Rosenv., 61, p. 787. *A. boreale* Strömf., 70, p. 32.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Antithamnion floccosum (Müll.) Kleen, Strömf., 70, p. 32.

E. Icel., SW. Icel., S. Icel.

Ceramium acanthonotum Carm., Kjellm., 36, p. 171.

SW. Icel., S. Icel.

Ceramium Deslongchampsii Chauv., Petersen, 57, p. 108; **Ceramium rubrum** ex pte. Jónsson, 31.

SW. Icel.: Reykjavík (L. Kolderup Rosenvinge, $\frac{5}{6}$ 1886).

Ceramium fruticosum Kütz., Petersen, 57, p. 108.

SW. Icel.: Seltjarnarnes (Helgi Jónsson, $\frac{28}{8}$ 1907).

Ceramium circinnatum Ag., Petersen, 57, p. 111; **Ceramium rubrum** ex pte. Jónsson, 31.

SW. Icel.: Stykkishólmur (Helgi Jónsson, $\frac{16}{6}$ 1897), Skerjafjörður (Helgi Jónsson, $\frac{10}{7}$ 1905).

Ceramium arborescens J. Agardh, Petersen, 57, p. 112; **Ceramium rubrum** ex pte. Jónsson, 31.

N. Icel.: Hrísey (Helgi Jónsson, $\frac{2}{7}$ 1898); NW. Icel.: Látravík in Aðalvík (C. H. Ostenfeld, $\frac{8}{7}$ 1896); SW. Icel.: Reykjavík (L. Kolderup Rosenvinge, $\frac{5}{6}$ 1886).

Ceramium atlanticum Petersen, 57, p. 112; **Ceramium rubrum** ex pte Jónsson, 31.

SW. Icel.: Gróttu (Helgi Jónsson, $\frac{17}{6}$ 1908), Hafnarfjörður (Hjalmar Jensen, $\frac{7}{5}$ 1890); S. Icel.: Staður (C. H. Ostenfeld, $\frac{12}{6}$ 1896), Eyrarbakki (Helgi Jónsson, $\frac{31}{5}$ 1897), Vestmannaeyjar (Helgi Jónsson, $\frac{14}{5}$ 1897).

Ceramium rubrum (Huds.) Agardh, Petersen, 57, p. 113; Jónsson, 31, ex pte.

N. Icel., NW. Icel., SW. Icel., S. Icel.

Rhodochorton Rothii (Turt.) Naeg., K. Rosenv., 61, p. 791.

E. Icel., N. Icel., NW. Icel., SW. Icel. (common), S. Icel.

Rhodochorton repens H. Jónsson, 31.

S. Icel.

Rhodochorton minutum Suhr. Descr. in Reinke's Atlas (59), Fig. Reinke's Atlas T. 40.

SW. Icel.

Rhodochorton penicilliforme (Kjellm.) K. Rosenv., Les Algues marines du Groenland in Ann. Sc. nat., 7^e Sér., XIX.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Rhodochorton membranaceum Magnus, K. Rosenv., 61, p. 794; P. Kuckuck, Beiträge zur Kenntniss der Meeresalgen, 1897.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Fam. Dumontiaceæ.

Dumontia filiformis (Fl. Dan.) Grev., Strömf., 70, p. 30.

E. Icel., SW. Icel. (rather common), S. Icel.

Dilsea edulis Stackh., Sarcophyllis edulis Kjellm., 36, p. 152.

SW. Icel.

Fam. Squamariaceæ.

Petrocelis Hennedyi (Harv.) Batters, A list of the Marine Algæ of Berwick-on-Tweed.

N. Icel.: Hraunakrókur (O. Davíðsson), NW. Icel., SW. Icel., S. Icel.

Cruoria arctica Schmitz, K. Rosenv., 61, p. 784.

SW. Icel.

Cruoria pellita (Lyngb.) Fries, Kjellm., 36, p. 142.

SW. Icel., S. Icel.: Eyrarbakki.

Peyssonellia Rosenvingii Schmitz, K. Rosenv., 61, p. 782; Hæmatostagon balanicola Strömf., 70, p. 25?

E. Icel., N. Icel., NW. Icel., SW. Icel.

Rhododermis parasitica Batters, A list of the Marine Algæ of Berwick-on-Tweed.

NW. Icel., SW. Icel., S. Icel.

Fam. Corallinaceæ.

Lithothamnion glaciale Kjellm., Strömf., 70, p. 18.

E. Icel., N. Icel., SW. Icel.

Lithothamnion Unger Kjellm., 36, p. 91 excl. syn.; L. intermedium Strömf., 70, p. 19.

E. Icel., N. Icel., NW. Icel.

Lithothamnion tophiforme Unger, Foslie, The Norwegian forms of Lithothamnion, 1895, p. 119; L. soriferum Strömf., 70, p. 18.

E. Icel., N. Icel., SW. Icel.: Hvalfjörður (Hörning), S. Icel.

Lithothamnion flavescens Kjellm., 36, p. 98.

E. Icel.

Lithothamnion foecundum Kjellm., 36, p. 99.

E. Icel., N. Icel.

Lithothamnion læve (Strömf.) Foslie, List of species of the Lithothamnion p. 7; Lithophyllum læve Strömf., 70, p. 21.

E. Icel., N. Icel., NW. Icel., SW. Icel., S. Icel.

Lithothamnion Lenormandi (Aresch.) Foslie, The Norwegian forms of Lithothamnion, 1895, p. 150.

SW. Icel.

Phymatolithon polymorphum (L.) Foslie, List of species of the Lithothamnion p. 8; Lithothamnion polymorphum Strömf., 70, p. 19.

S. Icel.

Clathromorphum compactum (Kjellm.) Foslie, Lithothamnion compactum Kjellm., 36, p. 101; *Clathromorphum circumscriptum* (Strömf.) Fosl., Lithothamnion circumscriptum Strömf., 70, p. 20.

In all parts of the coast.

Lithophyllum Crouani Fosl., List of species of the Lithothamnion, p. 10.

N. Icel., NW. Icel., S. Icel.: Eyrarbakki.

Dermatolithon macrocarpum (Ros.) Fosl., Revised systematical survey of the Melobesiæ, p. 21; Melobesia macrocarpa Strömf., 70, p. 23.

SW. Icel., S. Icel.

Corallina officinalis L., Strömf., 70, p. 18.

N. Icel., NW. Icel., SW. Icel., S. Icel.

Hildenbrandia rosea Kütz, Strömf., 70, p. 24.

Common around the coast of Iceland.

PHÆOPHYCEÆ.

Fam. Myrionemaceæ.

Lithoderma fatiscens Aresch., emend. Kuck., Bemerk. I (47), p. 238.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Petroderma maculiforme (Wollny) Kuck., Bemerk. II (47), p. 382.

N. Icel.

Ralfsia ovata K. Rosenv., 61, p. 900; 62, p. 94.

N. Icel.: Húsavík (Ove Paulsen), Prestsbakki; SW. Icel.

Ralfsia clavata (Carm.) Farl., Mar. Alg., p. 88; Reinke (59) Atlas T. 5 and 6, figs. 14—20; Stragularia adhærens Strömf., 70, p. 49, T. II, figs. 13—15.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Ralfsia verrucosa (Aresch.) J. Ag., Reinke (59), Atlas T. 5 and 6, figs. 1—13.

E. Icel., N. Icel., SW. Icel.

Ralfsia deusta (Ag.) J. Ag., K. Rosenv., 61, p. 898.

E. Icel., N. Icel., SW. Icel., S. Icel.

Myrionema vulgare Thuret, Sauvageau, 66, p. 185.

N. Icel., SW. Icel.

Myrionema Corunnæ Sauvag., 66, p. 237.

S. Icel.

Myrionema globosum (Rke) Fosl., New or critical Norw. Algæ, p. 17; *Ascocyclus globosus* Rke, 58, p. 46; Atlas (59) T. 17; *Phycocelis globosus* K. Rosenv., 62, p. 86, figs. 19—20.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Myrionema færðense Börgs., 13, p. 424.

SW. Icel.

Myrionema Laminariæ (K. Rosenv.), *Dermatocelis Laminariæ* K. Rosenv., 62, p. 89, fig. 21.

SW. Icel.

Ascocyclus islandicus H. Jónsson, 31, p. 149.

N. Icel.

Probably this species will prove to be identical with *A. sphærophorus* Sauv., cf. Jónsson, 31, p. 151 and Kylin.¹ The last-named author writes that *A. islandicus* without doubt is identical with *A. sphærophorus*, but he gives no particulars as to the chromatophores of the last-named species, I therefore must still regard the Icelandic plant as a distinct species.

Fam. **Ectocarpaceæ.**

Microsyphar Polysiphoniæ Kuck., Beiträge (48) p. 29.

NW. Icel., SW. Icel.

Streblonema æcidioides K. Rosenv., 61, p. 894; 62, p. 80; *Phycocelis æcidioides* Kuck., Bemerck. I (57), p. 234.

E. Icel., N. Icel., SW. Icel.

Streblonema Stilophoræ Cr. var. *cæspitosa* K. Rosenv., 61, p. 892.

Found in all parts of the coast.

Pylaiella littoralis (L.) Kjellm.; *Ectocarpus littoralis*, Kuck., 48, p. 7; Rosenv., 61, p. 881; *Pylaiella littoralis*, *Pylaiella varia* Kjellm., 35, p. 83.

Common around the coast of Iceland.

¹ Harald Kylin, Zur Kenntnis der Algenflora der Norwegischen Westküste, Arkiv för Botanik, Bd. 10, No. 1, 1910.

Ectocarpus tomentosoides Farl., New or imperfectly known Algæ of U. S., reprint from Bull. Torr. Bot. Club, Vol. XVI, 1889, p. 11, T. 87, fig. 4; K. Rosenv., 61, p. 180; Gran, En norsk form af Ectoc. tomentosoides Farl., Christiania Vidensk. Selsk. Forhandl. for 1883, No. 17; Kuckuck, Ueber Polymorphie bei einigen Phæosporeen in Festschrift für Schwendener, p. 370, figs. 5—7.

E. Icel., N. Icel., NW. Icel.; common in SW Icel. and S. Icel.

Ectocarpus tomentosus (Huds.) Lyngb., Hydr. Dan. (51) p. 132; Kjellman, 35, p. 73.

SW. Icel., S. Icel.

Ectocarpus confervoides (Roth) Le Jol., Kuck., 48, p. 19; Kjellman, 35, p. 77, ex pte.; K. Rosenv., 61, p. 883, ex pte.

Found in all parts of the coast.

Ectocarpus siliculosus (Huds.) Lyngb., Hydr. Dan. (51) p. 131; Kjellman, 35, p. 78; Kuck. 48, p. 15.

N. Icel., SW. Icel.

Ectocarpus penicillatus (Ag.) Kjellm., 35, p. 76; E. confervoides f. penicillata Kjellman, 39, p. 79.

E. Icel., N. Icel., SW. Icel.

Ectocarpus fasciculatus (Griff.) Harv., Kjellm. 35, p. 76.

SW. Icel., S. Icel.

Ectocarpus Hinksia Harv., Manual, p. 59; Phyc. Brit., T. 22; Sauvageau, Observations relatives à la sexualité des Phéosporées (Journal de Botanique, 1896).

S. Icel.

Fam. **Elachistaceæ.**

Leptonema fasciculatum Rke, 58, p. 50; var. subcylindrica K. Rosenv., 61, p. 879.

N. Icel., NW. Icel., SW. Icel.

Elachista fucicola (Vell.) Aresch., emend. K. Rosenv., 61, p. 878; E. fucicola Strömf., 70, p. 49. *α typica* is the most common, *β lubrica* (Rupr.) K. Rosenv. is rather common.

In all parts of the coast.

Fam. **Sphacelariaceæ.**

Sphacelaria britannica Sauvag., 67, p. 50.

N. Icel., SW. Icel., S. Icel.

Sphacelaria radicans Harv., Sauvag., 67, p. 27, fig. 14; Reinke, 60, T. III, fig. 1; Kuck., Bemerk. I (47), p. 229, fig. 4.

E. Icel., N. Icel., SW. Icel., S. Icel.

Sphacelaria olivacea Pringsh., emend. Sauvag., 67, p. 54.

NW. Icel., SW. Icel., S. Icel.

Chætopteris plumosa (Lyngb.) Kütz., Sauvag., 67, p. 44; Strömf., 70, p. 52; K. Rosenv., 61, p. 903; Reinke, 59, Atlas T. 49—50.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Fam. **Punctariaceæ.**

Omphalophyllum ulvaceum K. Rosenv., 61, p. 872, fig. 19.

E. Icel.

Punctaria plantaginea (Roth) Grev., K. Rosenv., 61, p. 871; 62, p. 71; Strömf., 70, p. 50.

E. Icel., N. Icel., NW. Icel.

Litosiphon filiformis (Rke), Pogotrichum filiforme Rke (59), Atlas, p. 62, T. 41, figs. 13—25; K. Rosenv., 61, p. 869; Kuck., Ueber Polymorphie bei einigen Phæosporeen, Festschrift für Schwendener, p. 360.

E. Icel., N. Icel., SW. Icel., S. Icel.

Isthmoplea sphærophora (Harv.) Kjellm., 36, p. 276; Reinke (59), Atlas T. 30; Pylaiella curta Foslie, Nye havsalger, in Tromsø Museums Aarshefter, X, 1887, p. 181; Kjellman, 35, p. 85; Fosliea curta Rke, Atlas, p. 45.

E. Icel., NW. Icel., SW. Icel., S. Icel.

Stictyosiphon tortilis (Rupr.) Rke, Atlas, T. 31—32; K. Rosenv., 61, p. 868; Phloeospora tortilis Strömf., 70, p. 51; Phloeospora subarticulata Kjellman, 39, p. 78.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Phæostroma pustulosum Kuckuck, Ueber einige neue Phæosporeen d. westl. Ostsee, Bot. Zeit. 1895, p. 182, T. VII; K. Rosenv., 62, p. 68, fig. 15.

E. Icel., NW. Icel., SW. Icel.

Scytosiphon Lomentaria (Lyngb.) J. Ag., K. Rosenv., 61, p. 863; 62, p. 62; Strömf., 70, p. 50.

In all parts of the coast.

Phyllitis zosterifolia Rke, 58, p. 61; K. Rosenv., 61, p. 862.

E. Icel., NW. Icel., SW. Icel., S. Icel.

Phyllitis fascia (O. F. Müll.) Kütz., K. Rosenv., 61, p. 862.

Gathered in all parts of the coast.

Fam. Dictyosiphonaceæ.

Coilodesme bulligera Strömf., 70, p. 48, T. II, figs. 9—12; K. Rosenv., 61, p. 862; 62, p. 61, fig. 13.

E. Icel., NW. Icel., SW. Icel.

Dictyosiphon Ekmani Aresch., Obs. phyc. 3 (7), p. 33.

SW. Icel.

Dictyosiphon Mesogloia Aresch., Obs. phyc. 3 (7); Reinke, 58, p. 64.

N. Icel.

Dictyosiphon Chordaria Aresch., Obs. phyc. 3 (7); Reinke, 58, p. 63; K. Rosenv., 61, p. 861; *Coilonema Chordaria* Strömf., 70, p. 51.

E. Icel., SW. Icel.

Dictyosiphon corymbosus Kjellm., 36, p. 267; Strömfelt, 70, p. 51.

N. Icel.

Dictyosiphon hippuroides (Lyngb.) Kütz.; Kjellm., 36, p. 268; Strömfelt, 70, p. 51.

N. Icel., NW. Icel., SW. Icel., S. Icel.

Dictyosiphon foeniculaceus (Huds.) Grev., Kjellman, 36, p. 269; K. Rosenv., 61, p. 859; Strömf., 70, p. 52.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Fam. Desmarestiaceæ.

Desmarestia viridis (Müll.) Lam., K. Rosenv., 61, p. 859; *Dichloria viridis* Strömf., 70, p. 51.

Common around the coast of Iceland.

Desmarestia aculeata (L.) Lam., Strömf., 70, p. 51; K. Rosenv., 61, p. 857.

Common everywhere along the coast.

Desmarestia ligulata (Lightf.) Lam.

S. Icel.: Vestmannaeyjar (Ove Paulsen).

Fam. Chordariaceæ.

Castagnea virescens (Carm.) Thur., K. Rosenv., 62, p. 58; *Eudesme virescens* Strömf., 70, p. 47.

E. Icel., N. Icel., SW. Icel.

Leathesia difformis (L.) Aresch., Kjellm., 36, p. 252.

N. Icel., SW. Icel.

Chordaria flagelliformis (Müll.) Ag., Strömf., 70, p. 47; K. Rosenv., 61, p. 854.

Common everywhere along the coast.

Fam. **Chordaceæ.**

Chorda tomentosa Lyngb., Hydrophytologia Danica, p. 74; K. Rosenv., 61, p. 854.

E. Icel., N. Icel., SW. Icel.

Chorda Filum (L.) Stackh., K. Rosenv., 61, p. 853; Strömf., 70, p. 47.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Fam. **Laminariaceæ.**

Saccorrhiza dermatodea (De la Pyl.) J. Ag.; K. Rosenv., 61, p. 850; *Phyllaria lorea* Strömf., 70, p. 42.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Laminaria saccharina (L.) Lam., Kjellman, 36, p. 229; 35, p. 24; Strömf., 70, p. 42.

f. typica;

f. linearis J. Ag., Kjellman 36, p. 229; 35, p. 25; Strömf., 70, p. 42; Börgesen, 13, p. 451, fig. 85;

f. latifolia Kjellm., 35, p. 26; *Laminaria saccharina f. latissima* Kjellm., 36, p. 230; Strömf., 70, p. 43?

This species is common everywhere along the coast, especially the principal form; *f. linearis* is rarer and *f. latifolia* is only met with in E. Icel. and NW. Icel. where it occurs gregariously.

Laminaria færoensis Börges., 13, p. 454.

E. Icel., N. Icel.

Laminaria nigripes J. Ag., emend. K. Rosenv., 61, p. 842.

β atrofulva (J. Ag.) K. Rosenv. (l. c.); *Laminaria discolor*, *Laminaria nigripes f. oblonga* Strömf., 70, pp. 43—44.

E. Icel.

Laminaria digitata (L.) Lam., Kjellman, 36, p. 240; 35, p. 22; Strömf., 70, p. 45.

f. genuina Le Jol. 49; Kjellman, 35, p. 23;

f. stenophylla Harv. Phyc. Brit., T. 338; *Laminaria stenophylla* Strömf., 70, p. 45; J. Ag. De Lam., p. 18; Kjellm., 35, p. 24;

f. cucullata Le Jol., 49.

F. genuina is common everywhere; *f. stenophylla*: E. Icel., SW. Icel., S. Icel.; *f. cucullata*: E. Icel., NW. Icel.

Laminaria hyperborea (Gunn.) Foslie, 20, p. 42; Strömf., 70, p. 44;
Laminaria Cloustoni Le Jol., 49, p. 577; fig., Fosl., 20, T. 1.

E. Icel., N. Icel., NW. Icel.; common in SW. Icel. and S. Icel.

Alaria Pylaii (Bory) J. Ag., emend. K. Rosenv., 61, p. 838; *Alaria Pylaii* and *Alaria membranifolia* Strömf., 70, p. 39.

f. *typica* K. Rosenv.;

f. *membranacea* (J. Ag.) K. Rosenv.

Common everywhere along the coast.

Alaria esculenta (L.) Grev., Kjellm., 36, p. 212; 35, p. 19; *Alaria esculenta*, *Alaria linearis* and *Alaria flagellaris* Strömf., 70, pp. 38—41; *A. flagellaris* K. Rosenv., 62, p. 49.

f. *australis* Kjellm.;

f. *fasciculata* Strömf.;

f. *pinnata* (Gunn.) Kjellm.

This species is exceedingly common everywhere along the coast.

Fam. **Fucaceæ.**

Fucus spiralis L., Kjellm., 36, p. 202; Strömf., 70, p. 35; Børgesen, 13, p. 472; *Fucus Areschougii* Kjellm., 35, p. 11.

f. *typica*;

f. *borealis* Kjellm.

E. Icel., N. Icel., SW. Icel., S. Icel.

Fucus inflatus L., M. Vahl, Fl. Danica (30), T. 1127; Foslie, Krit. Fortegnelse, Tromsø Mus. Aarshefter, IX, p. 109; Kjellm., 35, p. 11; K. Rosenv., 61, p. 834; Børgesen, 13, p. 465; *Fucus evanescens* Strömf., 70, p. 35; *F. edentatus*, *F. furcatus* and *F. evanescens* J. Ag., 3, p. 40; *F. furcatus* Kleen, 43, p. 29; *F. edentatus* De la Pyl., 15, p. 84.

f. *typica*.

F. furcatus Kleen ex pte.; *F. evanescens* auct. ex pte.;

F. edentatus De la Pyl.;

fig. Flora Danica (30) T. 1127; Børgesen, 13, figs. 90 and 91.

f. *evanescens* (C. Ag.)

F. evanescens C. Ag., Sp. p. 92 et auct. partim.

f. *linearis* (Huds.) K. Rosenv., 61, p. 834; *F. linearis* Hudson
 Flora anglica London 1762, Oeder Flora Danica (30) T. 351.

f. *exposita*.

F. distichus Lyngb. Hydr. Dan. (51) p. 6, exclus. syn.;

F. distichus α, robustior J. Ag. 3, p. 37, Kjellman 36, p. 210;

F. inflatus f. *disticha* Børgesen, 13, p. 465.

This species is common everywhere along the coast.

Fucus serratus L., Kjellm., 36, p. 196.

SW. Icel., S. Icel.

Fucus vesiculosus L., Kjellm., 36, p. 198; Strömf., 70, p. 34.

f. *typica*, fig. Harv. Phyc. Brit. T. 204.

f. *turgida* Kjellm.

f. *sphærocarpa* J. Ag.

This species is common everywhere.

Pelvetia canaliculata (L.) Dec. et Thur., Strömf., 70, p. 38.

SW. Icel., S. Icel.

Ascophyllum nodosum (L.) Le Jol., K. Rosenv., 61, p. 832; Ozo-
thallia nodosa Strömf., 70, p. 34.

Common along the coast.

CHLOROPHYCEÆ.

Fam. **Protococcaceæ.**

Chlorochytrium Cohnii Wright, K. Rosenv., 61, p. 963.

SW. Icel.

Chlorochytrium inclusum Kjellm., 36, p. 320, T. 31, figs. 8—17;
K. Rosenv., 61, p. 963; 62, p. 119.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Chlorochytrium dermatocolax Rke, 58, p. 88; K. Rosenv., 61, p.
964; Svedelius, 71, p. 72.

N. Icel., SW. Icel.

Chlorochytrium Schmitzii K. Rosenv., 61, p. 964; 62, p. 119.

SW. Icel.

Codiolum Petrocelidis Kuck., Bemerk. (47), p. 259, fig. 27.

SW. Icel.

Codiolum gregarium Al. Braun, Algarum unicellularum genera
nova et minus cognita, Lipsiæ, 1855, p. 19; Börgesen, 13, p. 517.

E. Icel.

Codiolum pusillum (Lyngb.) Kjellm., Börgesen, 13, p. 518; Vau-
cheria pusilla Lyngb. Hydr. Dan. 51, p. 72, T. 22.

N. Icel.

Fam. **Ulvaceæ.**

Percursaria percursa (Ag.) K. Rosenv., 61, p. 963.

SW. Icel.

Enteromorpha aureola (Ag.) Kütz., Tab. phyc., Vol. VI, T. 40, III; *Ulva aureola* Ag. Ic. alg. europ. (1), T. 29; *Capsosiphon aureolus* Gobi; *Ilea fulvescens* J. Ag., Ulvaceæ p. 114; ? *Solenia fulvescens* Ag., 2, p. 420; *Enteromorpha quaternaria* Ahlner in Wittr. et Nordstedt Alg. exsicc., Nos. 138 and 139.

N. Icel.

Enteromorpha Linza (L.) J. Ag., *Ulva enteromorpha* *a*, lanceolata Le Jol., 50, p. 42.

SW. Icel., S. Icel.

Enteromorpha intestinalis (L.) Link., emend. K. Rosenv., 61, p. 957; Börgesen, 13, p. 487.

f. *genuina* K. Rosenv. l. c. p. 957;

Enteromorpha intestinalis Strömf., 70, p. 52.

f. *micrococca* (Kütz.) K. Rosenv. l. c. p. 957.

f. *compressa* (L.) K. Rosenv. l. c. p. 958;

Enteromorpha compressa f. *typica* and

E. complanata f. *subsimplex* Strömf., 70, p. 53.

f. *minima* (Naeg.) K. Rosenv., l. c. p. 959;

Enteromorpha minima Strömf., 70, p. 53.

f. *prolifera* (O. F. Müller) Börgesen, 13, p. 490.

Enteromorpha prolifera K. Rosenv., 61, p. 960.

This species is common everywhere along the coast.

Enteromorpha clathrata (Roth) Grev., Kjellm., 36, p. 287; *Ulva clathrata* Le Jol., 50, p. 48 (partim); *Enteromorpha compressa* f. *racemosa* Strömf., 70, p. 53.

E. Icel., N. Icel., SW. Icel., S. Icel.

Monostroma groenlandicum J. Ag., K. Rosenv., 61, p. 954, fig. 53.

E. Icel., N. Icel., NW. Icel.

Monostroma Grevillei (Thur.) Wittr., emend. K. Rosenv., 61, p. 946.

var. *typica* K. Rosenv. l. c.

Monostroma Grevillei Wittr., 76, p. 57; Strömf. 70, p. 54 partim (e specim.).

var. *arctica* (Wittr.) K. Rosenv. l. c.

Monostroma arcticum Wittr., 76, p. 44; *Monostroma latisimum* Strömf., 70, p. 54.

var. *intestiniiformis* K. Rosenv. l. c.

Enteromorpha intestinalis Strömf., 70, p. 58 partim (e spec.).

Var. *typica* and var. *arctica* are common along the coast; var. *intestiniiformis*: E. Icel., SW. Icel.

Monostroma undulatum Wittr. 76, p. 46, T. III, fig. 9; K. Rosenv., 61, p. 945; *Monostroma Grevillei* Strömf., 70, p. 54 partim (e specim.).

In all parts of the coast.

Monostroma fuscum (Post. et Rupr.) Wittr., emend. K. Rosenv., 61, p. 940; *M. Blyttii*, Strömf. 70, p. 54.

f. *typica* is common along the coast; f. *grandis*.: E. Icel., N. Icel.

Ulva Lactuca L., K. Rosenv. 61, p. 839; Strömf., 70, p. 54.

N. Icel., NW. Icel., SW. Icel., S. Icel.

Fam. **Prasiolaceæ.**

Prasiola polyrrhiza (K. Rosenv.).

Gayella polyrrhiza K. Rosenv., 61, p. 936;

Prasiola crispa subsp. *marina* Börgesen, 13, p. 482;

Prasiola crispa f. *submarina* Wille, 73, p. 13.

SW. Icel., S. Icel.

Prasiola furfuracea (Mert.) Menegh. Imhäuser, 29, p. 266; Foslie Contrib., I, p. 127; Börgesen, 13, p. 486.

E. Icel., N. Icel., SW. Icel.

Prasiola stipitata Suhr; Imhäuser, 29, p. 272; Kjellman, 36, p. 303.

E. Icel., N. Icel., SW. Icel., S. Icel.

Fam. **Ulothricaceæ.**

Ulothrix consociata Wille, 73, p. 25.

var. *islandica* H. Jónss.

N. Icel.

Ulothrix subflaccida Wille, 73, p. 29.

E. Icel., N. Icel.

Ulothrix pseudoflaccida Wille, 73, p. 22, T. II, figs. 64—81.

E. Icel., SW. Icel., S. Icel.

Ulothrix flacca (Dillw.) Thur., K. Rosenv., 61, p. 935, fig. 44; Wille, 73, p. 18, T. I—II, figs. 54—63.

Common around the coast of Iceland.

Fam. **Chætophoraceæ.**

Pseudendoclonium submarinum Wille, 73, p. 29, T. III, figs. 101—134.

E. Icel.

Entoderma Wittrockii (Wille) Lagerh., K. Rosenv., 61, p. 934.

N. Icel., SW. Icel., S. Icel.

Acrochæte parasitica Oltm. Bot. Zeit. 1894, p. 208; K. Rosenv., 62, p. 114.

SW. Icel.

Acrochæte repens Pringsh., Beiträge p. 2, T. II; Huber, 28, p. 306.
NW. Icel.

Bolbocoleon piliferum Pringsh., Beiträge p. 2, T. II; Huber, 28, p. 308, pl. 13, figs. 8—12.

E. Icel., N. Icel., NW. Icel.

Fam. **Mycoideaceæ.**

Ulvella fucicola K. Rosenv., 61, p. 926, fig. 40. *Pseudopringsheimia fucicola* (Rosenv.) Wille in Engler u. Prantl: Die natürlichen Pflanzenfamilien, Nachträge zu I. Theil, Abtheil 2, p. 89.

E. Icel., N. Icel., SW. Icel., S. Icel.

Pringsheimia scutata Rke, 58, p. 81, Atlas T. 25.

NW. Icel., SW. Icel.

Ochlochæte ferox Huber, 28, p. 291, T. X; K. Rosenv. 61, p. 931, fig. 41.

N. Icel.

Fam. **Cladophoraceæ.**

Urospora mirabilis Aresch., K. Rosenv., 61, p. 918, fig. 35; 62, p. 106.
Common along the coast.

Urospora Hartzii K. Rosenv., 61, p. 922, fig. 38.

E. Icel., SW. Icel., S. Icel.

Urospora Wormskioldii (Mert.) K. Rosenv., 61, p. 920, fig. 36.

In all parts of the coast.

Chætomorpha tortuosa (Dillw.) Kleen, K. Rosenv., 61, p. 917.

E. Icel., N. Icel., SW. Icel.

Chætomorpha Melagonium (Web. et Mohr) Kütz., K. Rosenv., 61, p. 917; Strömf., 70, p. 55.

Probably common along the coast of Iceland.

Rhizoclonium riparium (Roth) Harv., K. Rosenv., 61, p. 913; 62, p. 103.

f. *polyrhiza* K. Rosenv., l. c. p. 913.

f. *valida* Fosl., K. Rosenv., l. c. p. 915.

f. *implexa* (Dillw.) K. Rosenv., l. c. p. 915.

E. Icel., N. Icel., SW. Icel.

Spongomorpha vernalis (Kjellm.) Wille, *Acrosiphonia vernalis* Kjellm., 41, p. 82.

SW. Icel.

Acrosiphonia albescens Kjellm., 41, p. 55, T. IV, fig. 21; Börgesen, 13, p. 507, fig. 103; *Spongomorpha arcta* Strömf., 70, p. 54, ex pte.

Common along the coast of Iceland.

Acrosiphonia incurva Kjellm. 41, p. 61.

Common along the coast.

Acrosiphonia hystrix (Strömf.) H. Jónss., 31.

f. *typica* H. Jónss., *Spongomorpha hystrix* Strömf., 70, p. 54, *Cladophora diffusa* Strömf., 70, p. 55 ex pte. (e specim.); *Cladophora* (*Spongomorpha*) *arcta* γ *hystrix* K. Rosenv., 61, p. 907.

f. *littoralis* H. Jónss.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Acrosiphonia flabelliformis H. Jónss., 31.

S. Icel.

Acrosiphonia penicilliformis (Fosl.) Kjellm., 41, p. 80 forma.

E. Icel.

Cladophora rupestris (L.) Kütz., K. Rosenv., 61, p. 909; Strömf., 70, p. 55.

N. Icel., NW. Icel., SW. Icel., S. Icel.

Cladophora hirta Kütz., Kjellm., in Wittr. et Nordstedt Exsicc., No. 1041.

SW. Icel., S. Icel.

Cladophora sericea (Huds.) Aresch., 8, p. 194, forma.

N. Icel., SW. Icel., S. Icel.

Cladophora glaucescens (Griff.) Harv., Phyc. Brit. T. 196; Le Jol. Alg. mar. d. Cherb. Exsicc., 66.

SW. Icel.

Cladophora gracilis Kütz., Kjellm. in Wittr. et Nordstedt Exsicc., No. 1040.

E. Icel., N. Icel., SW. Icel.

Fam. **Gomontiaceæ.**

Gomontia polyrrhiza (Lagerh.) Born. et Flah. sur deux nouv. gen. d'Algues perfor. Journ. de Bot. Tom. II, 188, p. 163.

E. Icel., N. Icel., NW. Icel., SW. Icel.

Fam. Phyllosiphonaceæ.

Ostreobium Queketti Born. et Flah., Sur quelques plantes vivant dans le test calcaire des mollusques, p. 15, pl. IX, figs. 5—8.

E. Icel., N. Icel., NW. Icel., SW. Icel.

CYANOPHYCEÆ.**Fam. Chamæsisphonaceæ.**

Pleurocapsa amethystea K. Rosenv., 61, p. 967, var.

E. Icel., N. Icel.; common in NW. Icel., SW. Icel. and S. Icel.

Fam. Oscillatoriaceæ.

Plectonema norvegicum Gomont, Bull. de la Soc. bot. de France, tome XLVI, 1899.

N. Icel.

Phormidium autumnale (Ag.) Gomont, emend. Johs. Schmidt, 68, pp. 348 and 410.

E. Icel.

Spirulina subsalsa Ørsted, Beretning om en Excursion til Trindelen, Krøyers Tidsskrift 3. Bd., pp. 566, 1842.

N. Icel., S. Icel.

Fam. Rivulariaceæ.

Calothrix scopulorum (Web. et Mohr) Ag., emend. Johs. Schmidt, 68, pp. 390 and 414.

E. Icel., N. Icel.

Rivularia atra Roth, Catalecta botanica, III, p. 340, 1806.

SW. Icel.

II. LIFE-CONDITIONS OF THE MARINE ALGAL VEGETATION.

1. THE NATURE OF THE COAST.

THE coast of Iceland consists partly of rock and partly of sand. The rocky coasts are rich in algal vegetation, while the sandy coast is most frequently a "desert." Here and there vegetation may be found, however, on the sandy coast, where this is not exposed to violent movement during any length of time. The vegetation then consists of short-lived species.

The Rocky Coast. This abounds in indentations of various size: inlets, fjords and bays. The size of the fjords varies greatly; for example, the largest, Faxaflói, is ten geographical miles long and twelve geographical miles broad, and Breiðifjörður is eighteen geographical miles long and ten geographical miles broad. The smaller fjords, on the other hand, are short and narrow indentations. Thus, owing to the indentations on the coast, the exposure is apt to vary greatly. The extreme points and the outer portions of the fjords have, as a rule, an exposed position, while in the interior of the fjord the water is generally calm.

The rocks on the coast consist of basalt; in some places, however, tuff-coasts exist, and especially on the south coast. The fjord-coasts of Iceland, which comprise South-west, North-west, North and East Iceland, are mainly composed of basalt. The basalt varies considerably but, as far as I have seen, it has no significance as regards the distribution of the species, and no difference is seen, for example, in the vegetation on the dolerite and the ordinary basalt coasts. What is of prime importance to the vegetation is not the rock itself but the nature of its surface. The surface is, as a rule, very uneven, being eroded by water, weather and wind, and furrowed by numerous fissures. Its nature is, therefore, such that the algæ can easily attach themselves to it.

The rocky coast is, as a rule, of solid rock, consisting of preglacial basaltic lava. Postglacial basaltic lava is found, nevertheless, in some places, as for example on Snæfellsnes. In many places, large stretches of the coast are covered with debris (Urð) from the mountains. Where the debris or the new lava predominates the surface is generally very uneven, and one then finds distinct elevations with large and small depressions interposed; such a coast is usually covered with an abundant and multifarious algal vegetation, if the conditions are in other respects favourable to the existence of algæ.

There is no range of skerries (Skærgaard) as there is, for example, on the coast of Norway. Yet a number of islands and rocks occur in the fjords, especially in Breiðfjörður. In this fjord are found indications of a range of skerries running parallel with the coast and along a considerable stretch of it, and marking the outward limit of the *Zostera*-vegetation.

The Sandy Coast. Almost the entire coast of S. Iceland is sandy shore or gravel shore. As a rule, such bottoms afford a mobile substratum because each wave which breaks on the beach shifts the particles backwards and forwards. A sandy coast is also met with, here and there, in other parts of the country, but is then found, as a rule, alternating with rocky parts; thus, the sandy or gravelly shore is often predominant at the head of small indentations which at the sides are bounded by projecting masses of rocks.

Clayey Shore is also found fairly frequently in the interior of the fjords.

The rocky coast is, as a rule, abundantly overgrown, and this is frequently the case also with the sublittoral gravel-bottom, while the sand and gravel bottoms laid bare periodically by the shifting tide are not, as a rule, overgrown, and, in any case, only with short-lived species. On clayey and muddy bottoms, on the other hand, algæ are seldom or never found, while *Zostera* often covers such a bottom and forms submarine "green meadows."

Despite the small "desert" areas, one may say that the coasts are covered with a zone of continuous algal vegetation — if we exclude the eastern portion of S. Iceland. This algal zone varies greatly in width, accommodating itself to the precipitousness of the coast. In a bay as shallow as Faxaflói the algal vegetation has a great extension seawards, while it is far more limited, for example, on the steeply descending submarine declivities in the fjords of the east coast.

2. THE OCEAN.

As regards the ocean, the chief points are its movements, temperature and salinity.

A. The Movements of the Ocean.

These are — tides, waves and currents. All these movements of the ocean are of very great importance to the life of the algæ.

a. Tides. By the alternate rise and fall of the tide a part of the shore is laid bare, and the vegetation growing there must then be capable of maintaining life in the air for a longer or shorter period. Those plants which grow highest up in the zone thus left dry, are exposed during the greater part of the period between the one flood-tide and the next, or for about 10—11 hours in every 12. The plants occurring lowest down in the zone, on the other hand, are not exposed during spring-tide for more than one hour in every 12, and they are submerged the whole time during neap-tide. The upper limit of the algal vegetation is, moreover, dependent on how high the tide rises, i. e. the height of the flood-tide.

The Height of the Flood-tide. The following data regarding the height of the flood-tide are taken from “Den islandske Lods” (1903) and from the alterations and additions to it which have been published. The height of the flood-tide is greatest in SW. Iceland and least in E. Iceland. The height of the flood-tide at spring-tide is recorded as being about 14 feet from Reykjavík (SW. Iceland), 10—11 feet from NW. Iceland, 5—5½ feet from the north coast and 5 feet from E. Iceland.

In many places there is a great difference as regards the height of the flood-tide during the spring and neap tides. To illustrate this more fully I give the following figures from some localities on the different parts of the coast: —

	Spring-tide	Neap-tide
South Iceland, Vestmannaeyjar	8—10 feet	4 feet
— Eyrarbakki	10 -	6 -
South-west Iceland, Reykjavík	cir. 14 -	4 -
— Stykkishólmur	12 -	6 -
North-west Iceland, Dyrafjörður	11 -	5—6 -
North Iceland, Akureyri	5½ -	1½ -
East Iceland, Djúpivogur	7½ -	2½ -

From Elliðaey near Stykkishólmur in SW. Iceland the height of the flood-tide during spring-tide is recorded as being 14 feet and

during neap-tide 7 feet, and it is also recorded from the latter place that the low-water at neap-tide lies about 3 feet above that at spring-tide.

When extraordinary conditions prevail the height of the flood-tide may be still greater; thus, 18—19 feet has been recorded from Reykjavík and 18 feet from Stykkishólmur.

From this it is seen that the height of the flood-tide varies greatly, which must necessarily affect the algal vegetation in several respects, especially as concerns the upper limit of its growth. Thus there is a great difference in the highest flood-mark (at spring-tide) and in the lowest flood-mark (at neap-tide). The tidal wave or the tide, moreover, shows irregularities, because neither the highest flood-mark (spring) nor the lowest flood-mark (neap-tide) is constant. The limit of the flood-tide fluctuates perpetually between a high-mark and a low-mark. The high-mark or the highest limit of the flood-tide is seen distinctly on rocky coasts from the action of the sea on the rock. On flat coasts, the high-mark can be distinguished by detached algæ and various other bodies which accompany the tidal wave and remain at the highest level reached by the water. This high-mark lies considerably higher than the upper limit of the algal vegetation.

The low-mark is not as easy to distinguish as the high-mark, but it will almost coincide with the upper limit of the *Pelvetia-Fucus spiralis* association. Above this the *Bangia* association (*Ulothrix*, *Bangia*, and others) is found, the extreme limit of which will almost coincide with an average water-level which, however, does not lie midway between low-mark and high-mark, but rather nearer the former. The upper limit of the algal vegetation thus lies somewhat above the limit of the flood-tide at neap-tide. The same rule holds good, of course, on a very exposed coast. That the place is exposed means that there is a heavy swell, which causes the sea to rise higher up on the coasts, both at neap-tide and at spring-tide.

By the upper limit of the marine algal vegetation is meant that boundary line above which marine algæ do not occur in the form of associations; on the other hand, no account is taken of single individuals or groups of individuals being found higher up, in crevices or pools, as such an occurrence must be considered accidental, because they are carried up to this height with the high water or by far-reaching breakers. They do live, of course, but do not thrive, and have evidently gone beyond their real area of distribution. In

this respect, however, those species should be excepted which can grow both in salt and in fresh water, as for example, *Enteromorpha intestinalis* (the principal form) and others. Naturally, such species cannot be taken into account when defining the upper limit of growth of marine algal vegetation.

If we compare the upper limit of the marine algal vegetation in Iceland with the same limit in Greenland it appears that they agree almost completely, as Rosenvinge (63, p. 89) sets the limit in Greenland almost at flood-mark at neap-tide. On the other hand there seems to be an incongruity with the Færøes, as Børgesen (11 and 12) sets the limit far above highest flood-mark in exposed places and almost at uppermost flood-mark in sheltered places.

If we institute comparisons with more distant coasts, for instance with the west coast of Sweden, the algal vegetation of which has lately been described by Kylin (43), we find that, as regards the upper limit, the case is the same as in Iceland, that is, the upper limit is coincident with an average water-level which lies higher in exposed places than in sheltered ones.

In Iceland, indeed, on a very exposed coast, marine algæ can be found rather high up, and if the sea is smooth and calm they may appear to be rather far away from the water; but on returning to the same place when the sea is in motion we see that it washes over them, and we no longer think it strange that they grow in so high a position. While the marine algal vegetation, as mentioned before, only extends upwards to an average water-level, it frequently happens on flat coasts that the land-vegetation is submerged at spring-tide. This occurs both in the interior of the fjords and on the lower islands, and may generally be distinguished by the appearance and the components of the vegetation; marine algæ, however, do not occur among such vegetation.

Some phanerogams, e. g. *Atriplex*, *Mertensia*, *Cakile*, etc., also grow below the upper limit of the littoral zone. According to Rosenvinge it happens in Greenland also that the land-vegetation is submerged at spring-tide.

b. The Swell. Here, those inequalities in the surface of the ocean which in every-day language are called waves, and that volume of water which, with a sea-wind is forced in towards the land, are treated collectively. The volume of water which is driven towards the coast by a sea-wind raises the water-level. While the tidal wave rises, the sea moved by the wind works together with

it, but when the water falls it counteracts the tidal wave; this circumstance is of great importance on exposed coasts where the wind blows frequently, as it shortens the period of desiccation. These movements in the sea are naturally somewhat irregular, but the irregularities are quite equalized in the long run, and therefore the effect of these movements may very well be regarded as constant. The high-mark which the water leaves on the coasts is due to the tide and to these movements jointly.

A frequent sea-wind has a favourable effect on the vegetation in the zone laid bare by the tide, as mentioned above, but where a frequent land-wind is blowing the effect is the reverse, as this counteracts the rise of the tidal wave and accelerates its fall, whereby the period of desiccation is prolonged.

The effect of the waves beating on the algæ is great. In exposed places, that is in places where the swell is heavy, the plants must be able to withstand the drag of the waves. The species which grow in these places therefore have a tough, leathery and narrow frond, whereas species in quiet waters have a delicate frond, often broad and brittle. The consistency of the frond thus accommodates itself to the force of the beat of the waves, and in partially exposed places, or in places where the beat of the waves is not strong, but yet fairly considerable, we find the consistency of the frond to be about midway between what it is in exposed and in calm places.

Like all other movements of the sea, the waves also are of great importance to the algal vegetation by the fact of their constantly providing fresh particles of water.

c. Currents (Fig. 2). Along the coast of Iceland the warm water of the Atlantic Ocean meets the cold water of the Arctic Ocean. The Gulf Stream washes the south coast of the country and sends an arm northward along SW. Iceland and NW. Iceland, and along the entire north coast warm water can be traced (the eastern arm of the Irminger Current) to Langanes; and from thence the arm turns toward the south along the coast of E. Iceland (Nielsen, 52, p. 13), where it mixes with water from the East Iceland polar current, which comes from the Norwegian Sea (Helland-Hansen and Nansen, 27, p. 287, where the current is called the East Iceland Arctic Current). In this manner characteristic coast-water arises at E. Iceland. Regarding this Nielsen (52, p. 13) writes that the Irminger Current "gives the waters over the coast shoal of East

Iceland a physiognomy different from that of the surrounding sea, the distribution of temperature being different even if the temperature is not in any important degree higher than in the East Icelandic polar current itself."

The conditions of the currents in N. and E. Iceland are evidently very complicated, and only the direction of the current of the warm water has been given above in outline, but as the observations are so few it is difficult to form an opinion as to how the condi-

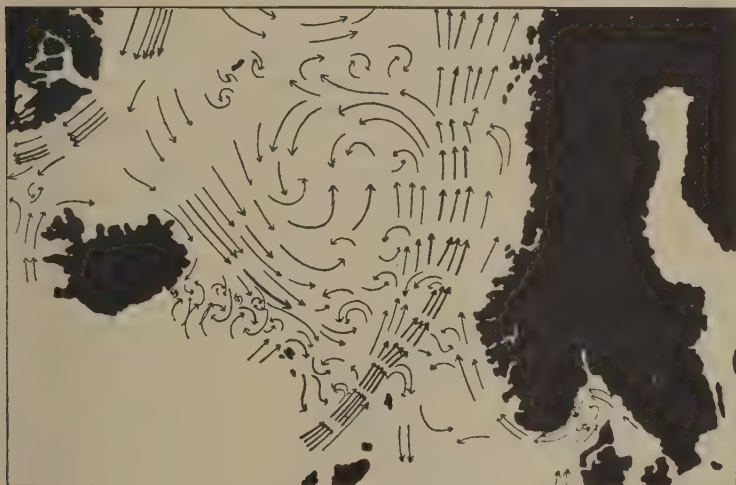


Fig. 2. Map of Currents.
(Helland-Hansen and Nansen.)

tions of the currents along these coasts vary in other respects from year to year or according to the seasons.

Further, other current-movements occur in the coast-water which may be deemed to be of importance to the vegetation, that is, such movements as are due to varying specific gravity. In the summer (Nielsen, 52, p. 8) the surface-water along the coast is lighter on account of its mixing with fresh water. A surface-current from the coast outwards then arises, and an under-current from the depth towards the coast. In the winter the surface-water along the coast becomes heavier owing to cooling, and sinks. Then a surface-current from the ocean towards the coast arises, and an under-current from the coast towards the depth.

B. The Temperature of the Water.

a. The temperature of the ocean around the coasts is not sufficiently known, and consequently the mean values cannot be given. I give, therefore, as an example, some actual measurements, as even these may be instructive in several respects. As regards NW. Iceland, N. Iceland and the northernmost part of the coast of E. Iceland I rely on the measurements carried out during the year 1904 on board the Danish Deep Sea Exploration ship "Thor" (Nielsen, 52).

East Iceland just south of Langanes.

April 24. St. 15, 66° 09' N. lat.
14° 26' W. long.

178 m.

Depth (m.)	Temp. (C°)	Salinity ‰
0	0.63	34.70
25	0.74	34.72
50	0.73	34.72
100	0.71	34.72

Aug. 12. St. 99, 66° 10' N. lat.
14° 29' W. long.

189 m.

Depth (m.)	Temp. (C°)	Salinity ‰
0	7.60	34.43
10	7.53	34.44
25	6.90	34.51
50	5.89	34.69
75	5.20	34.78
100	4.61	34.85

Aug. 13. St. 100, 66° 16' N. lat.
13° 36' W. long.

284 m.

Depth (m.)	Temp. (C°)	Salinity ‰
0	8.57	34.51
10	8.31	34.51
25	6.00	34.69
35	4.87	—
50	3.58	34.88
75	3.32	34.91
100	3.08	34.92

North Iceland east of Eyjafjörður.

April 23. St. 14, 66° 32' N. lat.
17° 50' W. long.

175 m.

Depth (m.)	Temp. (C°)	Salinity ‰
0	1.50	34.85
25	1.65	34.87
50	1.68	34.87
100	1.70	34.85

July 21. St. 74, 66° 33' N. lat.
18° 10' W. long.

75 m.

Depth (m.)	Temp. (C°)	Salinity ‰
0	8.40	33.91
10	7.49	34.79
17	7.19	34.85
21	6.34	—
25	5.49	34.82
50	5.06	34.87
73	4.81	34.88

July 21. St. 73, $66^{\circ} 14' \text{ N. lat.}$
 $17^{\circ} 28' \text{ W. long.}$

Aug. 15. St. 104, $66^{\circ} 14' \text{ N. lat.}$
 $17^{\circ} 28' \text{ W. long.}$

197 m.			226 m.		
Depth (m.)	Temp. (C ^o)	Salinity ‰	Depth (m.)	Temp. (C ^o)	Salinity ‰
0	10.5	31.62	0	8.60	34.27
10	7.12	31.11	10	8.52	34.27
17	6.52	34.43	25	7.84	34.47
25	6.74	34.69	35	6.71	34.60
50	5.95	34.76	50	5.90	34.82
75	5.37	34.88	75	5.63	34.86
100	4.84	34.96	100	5.40	34.91

North Iceland west of Eyjafjörður.

April 23. St. 13, $66^{\circ} 30' \text{ N. lat.}$
 $20^{\circ} 47' \text{ W. long.}$

Aug. 23. St. 106, $66^{\circ} 19' \text{ N. lat.}$
 $20^{\circ} 38' \text{ W. long.}$

220 m.			222 m.		
Depth (m.)	Temp. (C ^o)	Salinity ‰	Depth (m.)	Temp. (C ^o)	Salinity ‰
0	2.34	34.94	0	4.50	32.18
25	2.41	34.96	10	4.70	32.94
50	2.47	34.97	17.5	5.65	33.53
100	2.46	34.97	25	6.30	33.89
			30	6.11	33.93
			37.5	4.42	33.95
			50	4.27	34.34
			62.5	5.45	34.75
			75	5.62	34.83
			90	5.84	34.94
			100	6.12	35.05

April 23. St. 12, $66^{\circ} 31' \text{ N. lat.}$
 $22^{\circ} 25' \text{ W. long.}$

62 m.		
Depth (m.)	Temp. (C ^o)	Salinity ‰
0	1.20	34.76
40	1.05	34.81
60	1.05	34.81

June 2. St. 51, $66^{\circ} 29' \text{ N. lat.}$
 $22^{\circ} 25' \text{ W. long.}$

Aug. 24. St. 107, $66^{\circ} 30' \text{ N. lat.}$
 $22^{\circ} 27' \text{ W. long.}$

62 m.			46 m.		
Depth (m.)	Temp. (C ^o)	Salinity ‰	Depth (m.)	Temp. (C ^o)	Salinity ‰
0	3.52	34.67	0	8.91	34.58
10	3.49	34.67	10	8.96	34.58
25	3.49	34.70	20	8.93	34.58
60	3.49	34.70	30	8.91	34.58
			45	8.72	34.61

North-west Iceland.

April 22. St. 10, 66° 17' N. lat. 23° 14' W. long.			April 23. St. 11, 66° 33' N. lat. 23° 37' W. long.		
125 m.			84 m.		
Depth (m.)	Temp. (C°)	Salinity ‰	Depth (m.)	Temp. (C°)	Salinity ‰
0	1.42	34.69	0	2.40	34.97
50	2.82	34.99	82	2.97	—
120	2.94	35.05			
June 2. St. 52, 66° 20' N. lat. 23° 31' W. long.			Aug. 24. St. 108, 66° 19' N. lat. 23° 27' W. long.		
142 m.			115 m.		
Depth (m.)	Temp. (C°)	Salinity ‰	Depth (m.)	Temp. (C°)	Salinity ‰
0	4.25	34.92	0	9.42	34.67
10	4.24	34.92	10	9.52	34.66
25	4.17	34.98	25	9.46	34.66
50	4.19	34.99	35	9.39	—
75	4.25	34.99	50	8.16	34.85
100	4.34	35.01	75	7.37	34.91
			110	6.76	35.01

Almost at the boundary between NW. Iceland
and SW. Iceland.

June 26. St. 61, 65° 32' N. lat. 24° 34' W. long.			Aug. 26. St. 109, 65° 29' N. lat. 24° 37' 5 W. long.		
41 m.			43 m.		
Depth (m.)	Temp. (C°)	Salinity ‰	Depth (m.)	Temp. (C°)	Salinity ‰
0	8.17	34.13	0	10.26	34.54
5	7.93	34.25	10	10.20	34.54
10	7.77	34.34	15	10.20	34.53
20	7.66	34.50	25	10.21	34.54
40	7.61	34.52	40	10.21	34.57

The measurements recorded show distinctly the range of the temperature in April and August, 1904. By taking successively the stations 11 (April 23rd), 13 (April 23rd), 14 (April 23rd) and 15 (April 24th) it is distinctly seen how the temperature of the surface-water of the ocean along the north coast of Iceland decreases from west to east, as shown by the following figures: —

St. 11	St. 13	St. 14	St. 15
2.40°	2.34°	1.50°	0.63°

A similar decrease of warmth from west to east, but in a far lesser degree, appears to occur in the month of August.

Station 106 (Aug. 23rd) shows a much lower temperature than

was to be expected, which is unquestionably due to the water from the East Greenland polar current, as the ice was still, or had recently been, in the neighbourhood.

South Iceland.

From the ocean south of Iceland there are also measurements to hand carried out on board the "Thor" (Nielsen, 53).

South coast west of Dyrhólaey.

July 8. St. 63, 1904, $63^{\circ}32' \text{ N. lat.}$ \ $21^{\circ}30' \text{ W. long.}$ July 9. St. 64, 1904, $63^{\circ}08' \text{ N. lat.}$ $21^{\circ}30' \text{ W. long.}$

106 m.			662 m.		
Depth (m.)	Temp. (C°)	Salinity ‰	Depth (m.)	Temp. (C°)	Salinity ‰
0	10.89	35.14	0	10.44	35.16
25	9.77	35.14	25	10.18	35.16
50	8.06	35.14	50	8.07	35.16
104	7.85	35.16	100	7.67	35.19

July 12. St. 67, 1904, $63^{\circ}16' \text{ N. lat.}$ $19^{\circ}17' \text{ W. long.}$ Aug. 31. St. 114, 1904, $63^{\circ}25' \text{ N. lat.}$ $20^{\circ}03' \text{ W. long.}$

765 m.			150 m.		
Depth (m.)	Temp. (C°)	Salinity ‰	Depth (m.)	Temp. (C°)	Salinity ‰
0	11.45	35.03	0	11.70	34.49
25	10.09	35.14	10	11.70	34.51
50	8.14	35.21	20	11.55	34.65
100	7.77	35.21	30	11.31	34.92
			40	11.31	35.03
			45	10.95	35.07
			50	9.78	35.04
			75	7.97	35.22
			100	7.74	35.22

South coast east of Dyrhólaey.

May 23. St. 46, 1905, $63^{\circ}51' \text{ N. lat.}$ $16^{\circ}25' \text{ W. long.}$

60 m.		
Depth (m.)	Temp. (C°)	Salinity ‰
0	7.51	34.81
10	7.14	34.99
25	6.87	35.14
58	6.90	35.16

There are moreover some notes, given by Knudsen (44), on the temperature and salinity of the surface-water of the ocean south of Iceland. They are based upon the measurements carried out on

board the mail steamer "Laura" on its route from Scotland to Iceland during the years 1897—1904.

Between longitude 17° and 18° , near the coast of Iceland, in a south-easterly direction from Dyrhólaey, the mean temperature of the year (1897—1904) is stated (44) to be 8.8° and the mean salinity during the same period 35.19.

The main features regarding the temperature of the ocean around Iceland then are as follows — At the south coast warm, pure Atlantic water of a high (above 35 ‰) and somewhat varying salinity occurs; at SW. Iceland there is a somewhat similar sea; at NW. Iceland and N. Iceland there is Atlantic water mixed with cold water of low salinity from the East Greenland polar current; and lastly, at E. Iceland Arctic water occurs (with a temperature of 0° to 2° and salinity from 34.6 per cent. to 34.9 per cent. [Helland-Hansen and Nansen, 27, p. 287]): the East Iceland polar current mixed with water from the Atlantic current.

The change of temperature in the surface-layers of the water, the cooling process during winter and the heating process during summer, reaches down almost as deep as the algal vegetation, and is consequently of no slight importance to the latter.

b. The Temperature in the Fjords. Respecting the temperature of the surface-water of the ocean throughout the year information is given in the "Meteorologisk Aarbog" (Meteorological Year-book) regarding three stations in Iceland: Papey, Grímsey and Stykkishólmur. The following figures show the seasons' mean temperature of the ocean for a period of five years (1902—1906), chosen arbitrarily. Grímsey is omitted, however, as the observations there have often been incomplete.

	Winter	Spring	Summer	Autumn
Papey (E. Iceland)	0.9°	1.7°	6.0°	4.3°
Stykkishólmur (SW. Iceland). .	0.4°	1.8°	9.6°	6.4°
Vestmannaeyjar ¹ (S. Iceland).	4.1°	6.1°	10.4°	7.0°

The winter in Papey is warmer than in Stykkishólmur, and the monthly mean temperatures during the winter, of the period mentioned, are there all positive; while in Stykkishólmur, February (-0.8) and March (-0.2) have negative numbers. The summer is much warmer

¹ The figures for the Vestmannaeyjar constitute the mean of the period from July 1st, 1877 to Dec. 31st, 1906. According to Þorvaldur Thoroddsen, *Lysing Islands*, 2. Bd., pp. 350—351, Kaupmannahöfn 1910.

in Stykkishólmur. A comparison of these two places is, however, not equivalent to a comparison between E. Iceland and SW. Iceland, the situation of the stations being quite different. Papey is an island lying isolated in the ocean; Stykkishólmur, on the other hand, is a good example of the thermal conditions existing in the calm fjords.

Regarding the temperature at various depths in the interior of the fjords some observations are to hand made during the summer. These are, however, too few and scattered to be given in mean values. I give, therefore, as an example, some actual measurements from different parts of the coast of Iceland.

In East Iceland the measurements of temperature were carried out on board the Survey vessel "Diana" (Fisheries' Report ("Fiskeri-Beretning") for the financial year 1899—1900), and of these the following are given: —

	Depth in fathoms	Temp. (C°)
Hellisfjörður (¹⁹ / ₈)	0	1.7
	10	1.6
Laðmunðarfjörður (⁷ / ₆)	0	5.0
	cir. 33	1.5
Bakkafjörður (¹³ / ₆)	0	8.0
	7	2.5
Vopnafjörður (²⁰ / ₆)	0	4.5
	13 ¹ / ₂	1.8
Finnaafjörður (¹⁷ / ₆)	0	3.8
	8 ¹ / ₂	2.4
Finnaafjörður (¹⁸ / ₇)	0	6.5
	5	6.3
Breiðdalsvík (¹⁶ / ₈)	0	4.6
	Bottom	4.3

The low bottom-temperature in June is probably due to the East Iceland polar current.

In addition to these Sæmundsson¹ has published the following measurements of the temperature and salinity of the surface of the fjords in East Iceland.

	Temp. of the surface (C°)	Salinity ‰	
Djúpivogur (¹⁵ / ₈)	9.0	29.47	high-water.
—	7.4	33.14	low-water.
Fáskrúðsfjörður (¹⁹ / ₈) ..	10.0	33.67	at Búðir.
— ..	9.5	32.23	at Mjóeyri.
— ..	9.4	33.54	at Brimnes.
— ..	9.0	32.19	at Höfði.
— (²⁰ / ₈) ..	7.0	34.71	at Kolfreyjusstaður.

¹ Bjarni Sæmundsson, Fiskirannsóknir, 1898, Andvari, XXIV árg.

	Temp. of the surface (C°)	Salinity ‰	
Vattarnes (²¹ / ₈)	8.5	34.58	near land.
Eskifjörður (¹³ / ₈)	9.3	1.31	in the fjord, after rain.
— (²⁴ / ₈)	5.0	6.73	near land, outflowing current.
— —	5.0	23.71	out in the fjord, in outflowing current.
— —	5.0	34.45	out in the fjord, in inflowing current.
Norðfjörður (²⁷ / ₈)	7.5	34.45	near land.
Mjóifjörður (³⁰ / ₈)	6.5	33.00	at Brekka.
Seyðisfjörður (⁷ / ₈)	9.5	9.23	head of the fjord.
— (⁸ / ₈)	7.5	22.01	—
— —	8.0	22.01	out in the fjord.
— —	8.5	25.04	—
— —	7.8	30.65	—
— —	7.5	31.96	—
— (³¹ / ₈)	7.0	34.45	at Skálanes.
— (¹ / ₉)	7.0	34.45	at Brimnes.
— (³ / ₉)	6.5	33.01	at Dvergasteinn.
Borgarfjörður (⁴ / ₉)	7.1	34.45	out in the fjord.
Vopnafjörður (⁶ / ₉)	7.5	33.27	near land.

From the most westerly part of the north coast and from the northern part of the north-west coast as also from Breiðfjörður measurements are to hand of the temperature and salinity of the ocean at various depths in the interior of the fjords taken by Bjarni Sæmundsson (Fiskirannsóknir, 1908, Andvari, XXXIV árg.) of which the following are given: —

	Depth in metres	Temp. C°	Salinity ‰
North coast,			
Steingrímsfjörður (³¹ / ₇)	0	10.8	27.4
	15	9.7	
	30	9.2	34.3
	55	3.2	34.5
Steingrímsfjörður (² / ₈)	0	10.6	34.0
	15	9.9	
	35	7.8	34.6
	70	5.8	34.7
	100	4.2	34.7
Hrútafjörður (⁷ / ₈)	0	7.5	34.6
	15	6.0	
	30	4.8	34.7
	44	4.5	35.0
North-west coast,			
Mjóifjörður, the inner part (²⁰ / ₇)	0	11.8	30.6
	25	6.5	34.5
	50	3.2	34.9

	Depth in metres	Temp. C°	Salinity ‰
Skötuþfjörður, the inner part (¹⁶ /7)	0	11.4	30.5
	15	8.9	
	35	7.9	34.3
	70	7.4	34.7
	105	4.6	34.7
Isafjarðardjúp, 1½ mile NW. of Ögur- nes (¹⁸ /7)	0	11.8	32.2
	15	11.5	
	35	8.5	34.0
	70	6.8	34.9
	100	6.6	35.5
South-west coast,			
Skarðsstöð in Breiðifjörður (¹⁸ /8)	0	10.9	34.0
(outside)	8	10.8	34.5
Skarðsstöð	0	11.1	24.8
(near land)	6	11.0	34.3

Bjarni Sæmundsson has kindly given me the permission, moreover, to make use of his hitherto unpublished measurements of the temperature of the ocean at SW. Iceland (Breiðifjörður and Faxaflói), in the interior of the fjords, from the summer of 1909. Of these the following are given: —

	Depth in metres	Temp. C°	Salinity ‰
Breiðifjörður			
Stykkishólmur (the port ⁵ /7)	0	10.6	35.1
About ½ a mile SE. of Vaðstakksey (⁷ /7)	0	10.1	34.2
	15	10.1	
	30	10.1	34.6
	63	10.0	35.1
About ½ a mile SE. of Hrappsey (¹⁰ /7)	0	11.5	33.9
	15	10.8	
	30	10.7	34.0
	70	10.5	34.2
Kolgrafarfjörður, the interior (¹⁷ /7)	0	11.0	33.9
	10	10.6	
	20	10.6	34.2
	35	10.5	34.1
Kolgrafarfjörður, the mouth (¹⁸ /7)	0	9.8	34.7
	15	9.7	34.8
Hvammfjörður about 2 miles SE. of Lambey (¹⁰ /7)	0	11.4	32.7
	15	11.0	
	30	11.0	33.7
	45	10.9	34.1

	Depth in metres	Temp. C°	Salinity ‰
Faxaflói			
5 miles SW. of Akranes (²⁶ /7)	0	11.5	34.4
	15	10.6	
	30	9.2	34.7
	60	7.8	34.9
Knararnes	0	14.0	34.0
About 2 miles SE. of Þor- móðssker (⁸¹ /7).....	0	12.2	34.6
	15	10.2	
	30	9.5	34.6
	45	9.1	34.7
Borgarnes (⁸ /8).....	0	12.4	26.9
— (⁵ /8).....	0	12.4	18.9
Within Seleyri	0	11.2	8.8
	5	10.6	14.7
Borgarfjörður, the mouth (⁷ /8)	0	11.7	28.9
	10	11.6	
	20	11.5	34.4
Hvalfjörður, Hvammsdjúp (¹³ /8)	0	11.6	33.4
	15	11.4	
	30	11.2	34.0
	60	11.1	34.2
Hvalfjörður, Galtarvíkurdjúp	0	11.7	33.9
	15	11.5	
	30	11.1	34.0
	50	11.1	34.4
	85	11.0	34.3

high-water.
low-water.

From the measurements given above it will be seen that the temperature of the water in the interior of the small fjords is nearly the same from surface to bottom, while a regular decrease of warmth is immediately felt with the increase of depth in the more open waters. The temperature of the fjord-water is evidently dependent on the climate of the country; but regarding the temperature, during winter, for instance, we know nothing. Nor am I prepared to treat of the distribution of warmth in the coastal water in a more exact manner, as from the scattered observations made during the summer, which are at our disposal, no satisfactory results can be arrived at regarding the thermal conditions in which the algal vegetation exists all the year round.

C. The Salinity.

The degree of salinity is given above, together with the temperature.

a. The Sea. South of Iceland the salinity varies but slightly, with the exception of the coastal water itself. During the summer, at any rate, the salinity of the coastal water must be considerably lower on account of the great amount of fresh water brought down by all the rivers of the south. On the other coasts and especially those of N. and E. Iceland the salinity varies according to whether the layers of water originate from currents which are deficient in salt or from the Irminger current, and also with the amount of fresh water streaming out from land. At station 106 (see above) the inferior salinity is evidently due to cold water from the Greenland current, and at station 73 it is probably due to fresh water.

b. The Fjords. The salinity inside the fjords varies considerably and the variation is dependent upon the amount of fresh water which intermingles with the water in the fjord, partly in the form of river water and partly in the form of precipitated moisture. The lowest salinity in the fjords was 1.31 ‰ in Eskifjörður after rain. Heavy rainfalls must be capable of causing such an inferior salinity in other places also, especially in narrow fjords, but this will not last long, and as the littoral algæ can endure heavy showers during low-tide, they will not suffer to any extent worth mentioning.

In places where the salinity is as low as in Seyðisfjörður (9.23 ‰), where a rather large river disembogues, the algal vegetation occurs sparingly, although algæ are found, especially green and brown algæ. At a place like Borgarnes, where the salinity is low (18.9; 26.9) on account of fresh water from Hvítá, the algal vegetation occurs more abundantly than at the very head of Seyðisfjörður by the river, but the inferior salinity excludes certain species, for instance, *Polysiphonia fastigiata*, although *Ascophyllum* occurs abundantly. Further out, where the sea is more saline, it is not absent.

It is especially in the surface-water of the fjords that the salinity varies so much. It is greater in the large open fjords, such as Faxaflói, than in the small land-locked fjords, such as Hvalfjörður, a circumstance which must certainly be due to river-water. The figures given show also that the salinity of the surface-water of the smaller fjords is less in the inner part than in the outer part. The same difference seems to appear also between the deeper layers of water of the inner and outer parts.

As a rule, the salinity of the deeper layers is higher and more stable, which must be beneficial to the vegetation in the depths.

3. THE AIR.

The climate is of special importance to that part of the algal vegetation which is exposed during low-tide. The temperature is possibly of least importance in a climate where high and very low degrees of temperature do not occur, or are, at any rate, rare. The degree of humidity of the air and the cloud-covering are, on the other hand, highly important to the algal vegetation which is left dry. The movements of the air are also of importance, especially as it produces movements in the sea.

A. The Temperature.

The following means (19 years)¹ from a number of stations on different parts of the coast are here given for the elucidation of the thermal conditions.

	E. Iceland	Winter	Spring	Summer	Autumn	The year
Papey	— 1.1	0.1	6.0	3.3	2.1	
Berufjörður	— 1.4	0.8	7.6	3.5	2.6	
N. Iceland						
Raufarhöfn	— 4.0	— 1.9	6.5	1.6	0.5	
Grimsey	— 2.3	— 1.5	6.1	2.9	1.3	
SW. Iceland						
Stykkishólmur	— 2.2	0.8	8.9	3.9	2.9	
S. Iceland						
Vestmannaeyjar	1.1	3.8	9.7	5.2	5.0	
Eyrarbakki	— 2.0	2.1	10.2	3.5	3.5	

From the figures given above it will be possible to form an opinion of the thermal conditions in the places mentioned, and these are altogether such that an algal vegetation left dry can thrive everywhere along the coast. The extremes will not have a sufficiently injurious effect on the vegetation for it to be noticeable in the long run. High degrees of temperature, about 20° C for example, occur rarely in the summer, and will have no permanent effect. Very low degrees of temperature in the winter will not injure the vegetation left dry to any extent worth mentioning, as it is then partly protected by snow (at the very top) and partly by ice.

I do not consider the cold in the winter injurious to the vegetation which is left dry, as the algæ certainly endure being frozen fairly well. At least I have seen uppermost in the littoral zone,

¹ Willaume-Jantzen, Meteorologiske Middeltal og Extremer for Færøerne, Island og Grönland, Kjöbenhavn, 1899.

early in May, algæ which had been frozen hard during the night, apparently quite unharmed and alive when thawed, nor could one perceive next day that they had suffered at all; but, as I was travelling, I was not able to observe them more than these two days. It is also a foregone conclusion that the algæ left dry must freeze in the winter when the cold is severe, but it does not appear that they suffer thereby.

If the cold cannot be said to have any directly injurious effect, yet indirectly it may hurt the vegetation (though not to any great extent) by the fact that the water freezes and the beach becomes ice-covered. During severe winters a covering of ice may be found during the greater part of the winter in the smaller fjords, and especially where the fjord-water is abundantly mixed with fresh water, and even if the winters are quite mild, yet from time to time the water next the beach may freeze. In the littoral zone and on rocks which are laid bare during low-tide, the ice forms in accordance with the substratum, and if this is uneven the ice breaks. At high-water the ice-covering is lifted up; the pieces of ice may then freeze together again, and break once more with the next ebb-tide. During spring-tides in particular these movements are rather considerable and the plant-covering may be a good deal damaged thereby: but if one regards the coasts in their entirety these disturbances will prove to be of small importance.

The drift-ice is much more dangerous to the algal vegetation as the icebergs scrape the rocks with which they come in contact. Strömfelt, when travelling in Iceland in 1883, the year following one of the years notable on account of the great quantity of ice, found the littoral vegetation poorly developed in the north country. This most certainly resulted from the drift-ice having blockaded the coast during the whole summer of 1882. In the summer of 1898, I saw on the promontory between Seyðisfjörður and Loðmundarfjörður distinct signs of the drift-ice which had been there in the spring. The injurious influence of the drift-ice consists mainly in the fact that it scrapes away the vegetation from the parts with which it comes in contact; possibly also in the fact that it reduces the temperature to far below normal. That the plants suddenly find themselves in a much colder medium than they are accustomed to must produce a check upon them, particularly on the more sensitive species. The marine plants, however, are less affected by this than the land vegetation. As a rule, ice-years occur at fairly long intervals;

consequently the damage which the ice causes is not noticeable in the long run, it is noticed chiefly in the same year or the year following, and is remedied comparatively quickly.

B. The Humidity.

Very great importance must be ascribed to this as regards the algal vegetation left exposed. During the period of desiccation there is always the danger of the evaporation becoming too great, especially if the air is dry. The more humid the air, the better the algæ will be able to maintain life in it. The following figures from four places, each situated on a different part of the coast, show the mean humidity of the air as percentages (Willaume-Jantzen l. c.).

	Winter	Spring	Summer	Autumn
E. Icel. Berufjörður (23 years).....	77	78	81	80
N. Icel. Grímsey (21 years)	83	83	85	86
SW. Icel. Stykkishólmur (20-23 years) .	88	85	83	86
S. Icel. Vestmannaeyjar (12 years)	81	79	82	81

As a comparison with the Færøes might be of interest, the figures showing the mean humidity as percentages at Thorshavn (Willaume-Jantzen, l. c.) are appended.

	Winter	Spring	Summer	Autumn
Thorshavn in the Færøes (25 years)...	81	79	84	84

From these figures it appears that the humidity of the air in Berufjörður is less than in the Færøes while the humidity of the air at Grímsey and also at Stykkishólmur is greater than in the Færøes. The humidity of the air in the winter and the spring in the Vestmannaeyjar and in the Færøes is the same, while at the latter place it is a little greater in the summer and autumn.

C. Precipitation, Amount of Cloud, Foggy days, Wet days.

a. Precipitation. The following figures show for purposes of comparison the mean downfall in millimetres at four places in Iceland, one on each coast, and at Thorshavn in the Færøes (Willaume-Jantzen, l. c.).

	Winter	Spring	Summer	Autumn	The year
E. Icel. Berufjörður (23 years)...	348.0	222.7	203.7	340.3	1114.7
N. Icel. Grímsey (16-22 years)...	83.5	64.8	85.6	139.9	373.8
SW. Icel. Stykkishólmur (18-22 yrs.)	191.5	115.2	113.6	203.8	624.1
S. Icel. Vestmannaeyjar (15 years) ..	354.1	257.3	252.1	402.2	1265.7
Thorshavn in the Færøes (25 yrs.)	510.9	485.2	272.4	324.6	1593.1

As shown by the figures there is a considerable difference in the amount of precipitated moisture. That of Thorshavn is greatest, next come the Vestmannaeyjar, followed by Berufjörður. The precipitation at Stykkishólmur is not more than half that in the Vestmannaeyjar, and that of Grímsey is not more than a fourth part of that in the Vestmannaeyjar.

b. Mean Amount of Cloud (Willaume-Jantzen, l. c.).
Scale 0—10.

	Winter	Spring	Summer	Autumn
E. Icel. Berufjörður (23 years).....	6.4	6.6	6.9	6.6
N. Icel. Grímsey (22 years).....	8.5	8.2	7.9	8.5
SW. Icel. Stykkishólmur (22 years)....	7.1	6.4	6.0	6.9
S. Icel. Vestmannaeyjar (18 years).....	6.2	6.1	6.1	6.3
Thorshavn in the Færøes (25 years)..	7.4	7.1	7.7	7.5

The amount of cloud is greatest in Grímsey, and there is no great difference between the remaining three coast-stations in Iceland. In Thorshavn, however, the amount of cloud is considerably greater and consequently this place approximates to Grímsey.

c. Foggy and Wet days. Mean number of Foggy days (Willaume-Jantzen, l. c.).

	Winter	Spring	Summer	Autumn	The year
E. Icel. Berufjörður (23 years)..	44.0	52.0	67.0	49.0	212
N. Icel. Grímsey (22 years)...	2.4	13.0	31.0	7.0	53
SW. Icel. Stykkishólmur (22 years)	1.0	2.6	4.1	1.3	9
S. Icel. Vestmannaeyjar (18 years)	7.0	12.0	21.0	12.0	52
Thorshavn in the Færøes (25 yrs.)	3.0	10.0	29.0	9.0	51

The number of foggy days in Berufjörður is remarkably high, and at Stykkishólmur is extremely low. In Grímsey the number is much lower during the winter months, and higher during the summer months than it is in the Vestmannaeyjar; there are also small differences during spring and autumn. There are only small differences between the Færøes and the Vestmannaeyjar, except in the winter, when the Vestmannaeyjar have twice as many foggy days.

Mean number of Wet days (Willaume-Jantzen, l. c.).

	Winter	Spring	Summer	Autumn	The year
E. Icel. Berufjörður (23 years)..	52	43	34	48	177
N. Icel. Grímsey (22 years)...	40	29	29	45	143
SW. Icel. Stykkishólmur (22 years)	58	47	40	52	197
S. Icel. Vestmannaeyjar (18 years)	64	55	47	59	225
Thorshavn in the Færøes (25 yrs.)	81	66	58	74	279

At all seasons the number of wet days is highest in the Færøes

and in the Vestmannaeyjar, yet considerably higher in the former place. Grímsey has the fewest wet days, and Berufjörður and Stykkishólmur have somewhat similar numbers.

It is in the spring and the summer especially that the desiccation, during the period of exposure, may have an injurious effect in the zone laid bare along the coast. The amount of cloud is of course important, since clouds diminish the danger of desiccation, but the mean figures are not sufficiently elucidatory. Bright sunny days are not propitious to the vegetation left exposed, especially if several such days occur in succession; and if this takes place at neap-tide, the vegetation which is found above *Pelvetia-Fucus spiralis* is in danger. Although the weather in Iceland varies greatly, longer periods which are damp or dry often occur. Clear days are not uncommon in the spring and summer, and periods of even a week or more of bright weather are not rare. On bright sunny days in summer the temperature may rise rather high; I have measured 20° C. on such a day in a pool in the littoral zone, in the plant-covering itself, and the temperature of the air may rise even higher.

The periods of bright and dry weather are certainly of importance as regards the upper limit of growth of the algal vegetation during the summer. The Færøes are probably less favoured by clear weather than Iceland, and the difference in the upper limit of growth of the algal vegetation in Iceland and in the Færøes may possibly be partly explained by this.

D. Winds.

The following figures show the annual percentage (Willaume-Jantzen, l.c.) of the winds: —

	Berufjörður	Grímsey	Stykkishólmur	Vestmannaeyjar
N.	6	8	3	13
NE.	24	18	18	3
E.	4	20	20	23
SE.	6	16	16	9
S.	8	4	11	8
SW.	15	5	10	10
W.	4	12	7	8
NW.	23	7	3	4
Calm	10	10	12	22

It happens rather frequently that the winds are stormy and, as an example, the annual percentage of storms for Stykkishólmur (from $\frac{1}{9}$ 1845 to $\frac{31}{2}$ 1892) may be given: — N. 32, NE. 61, E. 13, SE. 17, S. 44, SW. 31, W. 26, NW. 11.

The frequency of "calm" is 10 % at Grímsey and in Berufjörður and the frequency of "wind" is therefore 90 % in both places; at Stykkishólmur the frequency of "calm" is 12 % and that of "wind" 88 %; in the Vestmannaeyjar the frequency of "calm" is 22 % and that of "wind" 78 %.

At Thorshavn, in the Færøes, the annual "calm" is 11 % and the frequency of "wind" 89 %, somewhat the same, therefore, as at Stykkishólmur and greater than in the Vestmannaeyjar.

4. LIGHT.

The influence of light on the distribution of the algal associations and on their appearance is, as is well-known, exceedingly great. Without doubt most investigators assume that the main division of algal vegetation into a green, a brown and a red zone is due to the quality of the light, but one cannot on that account consider the intensity of the light to be of no importance. To what extent the shades of colour in the red algæ are to be regarded as an adaptation to the intensity of the light or to the quality of the light, I find rather difficult to decide.

I agree with Berthold and Oltmanns in thinking that the *Florideæ* may be characterized as shade-plants in the same sense that we speak of shade-vegetation in lava-clefts and in other places where there is a faint light. By shade-plants I understand plants which prefer feebly illuminated spots, and do not, as a rule, thrive in the full light of day. In the tidal region (Part VI) the littoral *Florideæ* evidently prefer crevices and grottoes, i. e. feebly illuminated places, and thus prove themselves to be shade-plants.

I shall not enter more fully into the question of light, as I have made no experiments in that connection and, moreover, the subject requires to be reinvestigated (Oltmanns, 54).

III. THE HORIZONTAL DISTRIBUTION OF THE SPECIES AND THE COMPONENTS OF THE ALGAL FLORA.

IN the following list (Table I) of the hitherto known Marine Algae of Iceland a letter (A, B₁, B₂, C, D, E₁, E₂) is placed before each species, showing to which plant-geographical group I refer it (cf. Børgesen and Jónsson, 14). A indicates the arctic group, B₁ sub-division 1 of the subarctic group, B₂ sub-division 2 of the subarctic group, C the boreal-arctic group, D the cold-boreal group and E the warm-boreal group. The letter *c* placed after the name of the species indicates that it has been found in all the five coastal districts (E. Icel., N. Icel., NW. Icel., SW. Icel. and S. Icel., see above, p. 5); a (*c*) placed after the name of the species indicates that it probably occurs in all parts of the coast.

Table 1. The Distribution of the Species along the coast.

		E. Icel.	N. Icel.	NW. Icel.	SW. Icel.	S. Icel.
	Rhodophyceæ.					
C	<i>Bangia fusco-purpurea</i> (<i>c</i>)	+	+	..	+	+
C	<i>Porphyra umbilicalis</i> <i>c</i>	+	+	+	+	+
B ₂	<i>P. miniata</i> <i>c</i>	+	+	+	+	+
D	<i>Porphyropsis coccinea</i>	..	..	..	+	+
B ₂	<i>Conchocelis rosea</i> <i>c</i>	+	+	+	+	+
C	<i>Chantransia microscopica</i> (<i>c</i>)	..	+	..	..	..
D	<i>C. Alariæ</i>	..	..	..	+	+
C	<i>C. secundata</i> <i>c</i>	+	+	+	+	+
B ₂	<i>C. virgatula</i> (<i>c</i>)	..	..	+	+	..
E ₁	<i>Chondrus crispus</i>	..	..	(+)	+	+
D	<i>Gigartina mamillosa</i> (<i>c</i>)	+	+	..	+	+
C	<i>Ahnfeltia plicata</i>	..	(+)	(+)	+	+
B ₁	<i>Phyllophora Brodiai</i> * <i>interrupta</i>	+	..	+	..	..
D	<i>P. membranifolia</i>	..	..	..	+	+
B ₂	<i>Actinococcus subcutaneus</i>	+	..	+	..	..
A	<i>Ceratocolax Hartzii</i> ...	..	..	+	..	..
D	<i>Cystoclonium purpurascens</i>	..	+	+	+	+

Table 1. The Distribution of the Species along the coast (continued).

		E. Icel.	N. Icel.	NW.Icel.	SW.Icel.	S. Icel.
A	<i>Turnerella Pennyi</i>	+	+	..	..	..
B ₂	<i>Euthora cristata c.</i>	+	+	+	+	+
B ₁	<i>Rhodophyllis dichotoma (c)</i>	+	+	+	+	..
B ₂	<i>Rhodymenia palmata c.</i>	+	+	+	+	+
E ₁	<i>Lomentaria clavellosa</i>	..	..	..	..	+
D	<i>L. rosea</i>	..	..	..	..	+
E ₁	<i>Plocamium coccineum</i>	..	..	..	..	+
B ₁	<i>Halosaccion ramentaceum c</i>	+	+	+	+	+
D	<i>Delesseria alata</i>	..	..	..	+	+
A	<i>D. Baerii</i> * <i>corymbosa</i>	?	?	..	..	..
B ₂	<i>D. sinuosa c.</i>	+	+	+	+	+
D	<i>D. sanguinea</i>	(+)	..	..	+	+
E ₂	<i>Bonnemaisionia asparagoides</i>	..	..	..	..	?
E ₁	<i>Pterosiphonia parasitica</i>	..	..	..	..	+
D	<i>Polysiphonia urceolata c.</i>	+	+	+	+	+
D	<i>P. fastigiata</i>	..	..	+	+	+
A	<i>P. arctica</i>	+	+	+	+	..
D	<i>P. nigrescens</i>	..	+	..	+	..
B ₂	<i>Rhodomela lycopodioides c</i>	+	+	+	+	+
B ₂	<i>Odonthalia dentata c</i>	+	+	+	+	+
D	<i>Callithamnion Arbuscula</i>	..	..	..	+	+
E ₁	<i>C. scopulorum</i>	..	..	..	+	+
D	<i>Plumaria elegans</i>	..	..	..	..	+
B ₂	<i>Ptilota plumosa</i>	..	+	+	+	+
B ₁	<i>P. pectinata</i>	+	+	+	+	..
C	<i>Antithamnion Plumula v. boreale (c)</i>	+	+	+	+	..
D	<i>A. floccosum (c)</i>	+	..	..	+	+
D	<i>Ceramium acanthotum</i>	..	..	..	+	+
D	<i>C. Deslongchampsii</i>	..	..	..	+	..
D	<i>C. fruticulosum</i>	..	..	..	+	..
D	<i>C. circinnatum</i>	..	..	..	+	..
E ₁	<i>C. arborescens</i>	..	+	+	+	..
D	<i>C. atlanticum</i>	..	..	..	+	+
C	<i>C. rubrum (c)</i>	..	+	+	+	+
C	<i>Rhodochorton Rothii c</i>	+	+	+	+	+
D	<i>R. repens</i>	..	..	..	..	+
D	<i>R. minutum</i>	..	..	..	+	..
B ₁	<i>R. penicilliforme (c)</i>	+	+	+	+	..
C	<i>R. membranaceum (c)</i>	+	+	+	+	..
D	<i>Dumontia filiformis (c)</i>	+	..	..	+	+
D	<i>Dilsea edulis</i>	..	..	..	+	..
D	<i>Petrocelis Hennedyi</i>	..	+	+	+	+
A	<i>Cruoria arctica</i>	..	..	..	+	..
E ₁	<i>C. pellita</i>	..	..	..	+	+
B ₁	<i>Peyssonellia Rosenvingii</i>	+	+	+	+	..
D	<i>Rhododermis parasitica</i>	..	..	+	+	+

Table 1. The Distribution of the Species along the coast (continued).

		E. Icel.	N. Icel.	NW.Icel.	SW.Icel.	S. Icel.
B ₂	<i>Lithothamnion glaciale</i> (c).....	+	+	..	+	..
D	<i>L. Unger</i> (c).....	+	+	+	..	..
B ₁	<i>L. tophiforme</i> (c).....	+	+	..	+	+
A	<i>L. flavescens</i>	+	..	..	..	..
A	<i>L. foecundum</i>	+	+	..	..	..
B ₁	<i>L. læve</i> c.....	+	+	+	+	+
D	<i>L. Lenormandi</i>	..	..	..	+	..
D	<i>Phymatolithon polymorphum</i>	..	?	..	..	+
B ₁	<i>Clathromorphum compactum</i> c.....	+	+	+	+	+
D	<i>Lithophyllum Crouani</i>	..	+	+	..	+
D	<i>Dermatolithon macrocarpum</i>	..	..	..	+	+
D	<i>Corallina officinalis</i>	..	+	+	+	+
C	<i>Hildenbrandia rosea</i> c.....	+	+	+	+	+
Phæophyceæ.						
B ₁	<i>Lithoderma fatiscens</i> (c).....	+	+	+	+	..
D	<i>Petroderma maculiforme</i>	..	+	..	..	..
B ₁	<i>Ralfsia ovata</i> (c).....	..	+	..	+	..
B ₂	<i>R. clavata</i> (c).....	+	+	+	+	..
D	<i>R. verrucosa</i> (c).....	+	+	..	+	..
B ₁	<i>R. deusta</i> (c).....	+	+	..	+	+
D	<i>Myrionema vulgare</i>	..	+	..	+	..
D	<i>M. Corunnæ</i>	..	..	..	..	+
B ₁	<i>M. globosum</i> (c).....	+	+	+	+	..
D	<i>M. færoëense</i>	..	..	..	+	..
B ₁	<i>M. Laminariæ</i> (c).....	..	..	..	+	..
D	<i>Ascocyclus islandicus</i>	..	+	..	..	..
D	<i>Microsyphar Polysiphoniæ</i> (c).....	..	..	+	..	..
B ₁	<i>Streblonema æcidioides</i> (c).....	+	+	..	+	..
D	<i>S. Stilophoræ</i> v. <i>cæspitosa</i> c.....	+	+	+	+	+
C	<i>Pylaiella littoralis</i> c.....	+	+	+	+	+
B ₂	<i>Ectocarpus tomentosoides</i> c.....	+	+	+	+	+
D	<i>E. tomentosus</i>	..	..	..	+	+
C	<i>E. confervoides</i> c.....	+	+	+	+	+
C	<i>E. siliculosus</i> (c).....	..	+	..	+	..
D	<i>E. penicillatus</i> (c).....	+	+	..	+	..
D	<i>E. fasciculatus</i>	..	..	..	+	+
D	<i>E. Hinksii</i>	..	..	..	..	+
B ₂	<i>Leptonema fasciculatum</i> v. <i>subeylin-</i> <i>drica</i> (c).....	..	+	+	+	..
B ₂	<i>Elachista fucicola</i> c.....	+	+	+	+	+
B ₁	<i>Sphacelaria britannica</i> (c).....	..	+	..	+	+
D	<i>S. radicans</i> (c).....	+	+	..	+	+
D	<i>S. olivacea</i>	..	..	+	+	+
B ₁	<i>Chaetopteris plumosa</i> (c).....	+	+	+	+	..
A	<i>Omphalophyllum ulvaceum</i>	+	..	..	..	..

Table 1. The Distribution of the Species along the coast (continued).

		E. Icel.	N. Icel.	NW.Icel.	SW. Icel.	S. Icel.
B ₂	<i>Punctaria plantaginea</i> (c).....	+	+	+	..	..
B ₂	<i>Litosiphon filiformis</i> (c).....	+	+	..	+	+
B ₂	<i>Isthmoplea sphærophora</i> (c).....	+	..	+	+	+
B ₂	<i>Stictyosiphon tortilis</i> (c).....	+	+	+	+	..
B ₂	<i>Phæostroma pustulosum</i> (c).....	+	..	+	+	..
C	<i>Scytosiphon Lomentaria</i> c.....	+	+	+	+	+
D	<i>Phyllitis zosterifolia</i> (c).....	+	..	+	+	+
C	<i>Ph. fascia</i> c.....	+	+	+	+	+
B ₁	<i>Coilodesme bulligera</i>	+	..	+	+	..
D	<i>Dictyosiphon Ekmani</i>	..	..	..	+	..
D	<i>D. Mesogloia</i>	..	+	..	..	..
D	<i>D. Chordaria</i> (c).....	+	..	..	+	..
A	<i>D. corymbosus</i>	..	+	..	..	..
B ₂	<i>D. hippuroides</i> (c).....	..	+	+	+	+
B ₂	<i>D. foeniculaceus</i> (c).....	+	+	+	+	..
B ₂	<i>Desmarestia viridis</i> c.....	+	+	+	+	+
B ₂	<i>D. aculeata</i> c.....	+	+	+	+	+
E ₁	<i>D. ligulata</i>	..	..	..	..	+
D	<i>Castagnea virescens</i> (c).....	+	+	..	+	..
E ₁	<i>Leathesia difformis</i>	..	+	..	+	..
B ₂	<i>Chordaria flagelliformis</i> c.....	+	+	+	+	+
B ₂	<i>Chorda tomentosa</i> (c).....	+	+	..	+	..
B ₂	<i>C. Filum</i> (c).....	+	+	+	+	..
B ₁	<i>Saccorhiza dermatodea</i> (c).....	+	+	+	+	..
D	<i>Laminaria saccharina</i> c.....	+	+	+	+	+
B ₁	<i>L. færoënsis</i>	+	+	..	..	..
A	<i>L. nigripes</i>	+	..	..	..	..
B ₁	<i>L. digitata</i> c.....	+	+	+	+	+
D	<i>L. hyperborea</i> c.....	+	+	+	+	+
B ₁	<i>Alaria Pylaii</i> c.....	+	+	+	+	+
D	<i>A. esculenta</i> c.....	+	+	+	+	+
D	<i>Fucus spiralis</i> (c).....	+	+	..	+	+
B ₂	<i>F. inflatus</i> c.....	+	+	+	+	+
D	<i>F. serratus</i>	..	..	..	+	+
C	<i>F. vesiculosus</i> c.....	+	+	+	+	+
D	<i>Pelvetia canaliculata</i>	..	..	..	+	+
C	<i>Ascophyllum nodosum</i> c.....	+	+	+	+	+
Chlorophyceæ.						
B ₂	<i>Chlorochytrium Cohnii</i> (c).....	..	..	..	+	..
B ₂	<i>C. inclusum</i> (c).....	+	+	+	+	..
B ₂	<i>C. dermatocolax</i> (c).....	..	+	..	+	..
B ₁	<i>C. Schmitzii</i> (c).....	..	..	..	+	..
D	<i>Codiolum Petroceldis</i>	..	..	..	+	..
B ₂	<i>C. gregarium</i> (c).....	+	..	..	..	..
D	<i>C. pusillum</i> (c).....	..	+	..	..	..

Table 1. The Distribution of the Species along the coast (continued).

		E. Icel.	N. Icel.	NW.Icel.	SW.Icel.	S. Icel.
B ₂	<i>Percursaria percura</i> (c)	..	..	..	+	..
D	<i>Enteromorpha aureola</i>	..	+	..	..	..
E ₁	<i>E. Linza</i>	..	..	..	+	+
C	<i>E. intestinalis</i> c	+	+	+	+	+
C	<i>E. clathrata</i> (c)	+	+	..	+	+
A	<i>Monostroma groenlandicum</i>	+	+	+	..	..
B ₂	<i>M. Grevillei</i> c	+	+	+	+	+
B ₁	<i>M. undulatum</i> c	+	+	+	+	+
B ₁	<i>M. fuscum</i> c	+	+	+	+	+
C	<i>Ulva lactuca</i> (c)	..	+	+	+	+
D	<i>Prasiola polyrrhiza</i> (c)	..	..	..	+	+
D	<i>P. furfuracea</i> (c)	+	+	..	+	..
D	<i>P. stipitata</i> (c)	+	+	..	+	+
B ₁	<i>Ulothrix consociata</i> v. <i>islandica</i>	..	+	..	..	..
B ₁	<i>U. subflaccida</i> (c)	+	+	..	..	..
B ₁	<i>U. pseudoflacca</i> (c)	+	..	..	+	+
B ₂	<i>U. flacca</i> c	+	+	+	+	+
B ₂	<i>Pseudendoclonium submarinum</i> (c)	+	..	..	..	..
D	<i>Entoderma Wittrockii</i> (c)	..	+	..	+	+
B ₁	<i>Acrochaete parasitica</i> (c)	..	..	..	+	..
D	<i>A. repens</i>	..	..	+	..	..
B ₂	<i>Bolbocoleon piliferum</i> (c)	+	+	+	..	..
B ₂	<i>Ulvella fucicola</i> (c)	+	+	..	+	+
B ₂	<i>Pringsheimia scutata</i> (c)	..	..	+	+	..
D	<i>Ochlochaete ferox</i> (c)	..	+	..	..	..
B ₂	<i>Urospora mirabilis</i> c	+	+	+	+	+
B ₁	<i>U. Hartzii</i> (c)	+	..	..	+	+
B ₂	<i>U. Wormskioldii</i> c	+	+	+	+	+
C	<i>Chaetomorpha tortuosa</i> (c)	..	+	..	..	..
B ₂	<i>C. Melagonium</i> c	+	+	+	+	+
C	<i>Rhizoclonium riparium</i> (c)	+	+	..	+	..
B ₂	<i>Spongomorpha vernalis</i> (c)	..	..	..	+	..
D	<i>Acrosiphonia albescent</i> c	+	+	+	+	+
B ₂	<i>A. incurva</i> c	+	+	+	+	+
B ₁	<i>A. hystrix</i> (c)	..	+	+	+	..
D	<i>A. flabelliformis</i>	..	..	..	..	+
B ₁	<i>A. penicilliformis</i>	+	..	..	..	..
B ₂	<i>Cladophora rupestris</i>	..	..	+	+	+
B ₂	<i>C. hirta</i> (c)	..	..	..	+	+
B ₂	<i>C. sericea</i> (c)	..	+	..	+	+
D	<i>C. glaucescens</i> (c)	..	..	..	+	..
C	<i>C. gracilis</i> (c)	+	+	..	+	..
C	<i>Gomontia polyrrhiza</i> (c)	+	+	+	+	..
B ₂	<i>Ostreobium Queketti</i> (c)	+	+	+	+	..

Table 1. The Distribution of the Species along the coast (continued).

		E. Icel.	N. Icel.	NW.Icel.	SW.Icel.	S. Icel.
	Cyanophyceæ.					
B ₂	<i>Pleurocapsa amethystea</i> c.....	+	+	+	+	+
D	<i>Plectonema norvegicum</i> (c)	..	+	..	..	..
E	<i>Phormidium autumnale</i> (c)	+	..	..	..	..
C	<i>Spirulina subsalsa</i> (c)	..	+	..	+	..
C	<i>Calothrix scopulorum</i> (c)	+	+	..	..	..
C	<i>Rivularia atra</i> (c)	..	..	..	+	..

From Iceland (31, 14 and 57) there are published 76 species of red algæ, 67 species of brown, 51 of green and 6 of blue-green — 200 species in all. All of these, of course, are not equally common along the coast, and their habitats, as far as these are known, in the five districts into which the coast is divided, are given in the above table. That table shows that comparatively few species occur in all the coastal districts (in the table, such are indicated by the letter *c* placed after the name of the species). In all parts of the coast are found 15 species (20 %) of red algæ, 18 species (26.8 %) of brown, 10 species (19.6 %) of green and 1 species (16.6 %) of blue-green. Thus, of the 200 species there are 44 species (22 %) which are common to all the coastal districts.

If we take into consideration the fact that the great stretch of coast round the whole of Iceland is as yet far from accurately investigated, we may expect, after future investigations, not only that several more species will be found, but also that the distribution of the species in the different parts of the coast will prove to differ from what is at present stated to be the case. Therefore, in the above list of the distribution of the species along the coast I have placed a (*c*) after the name of those species which, as I surmise, are probably to be found in all parts of the coast. I base this supposition partly on the position of the habitats already known along the coast, and partly on the occurrence of the species in the adjacent floral districts, e. g. the Færøes and Greenland.

The mark (*c*) is subjoined to 14 species of red algæ, 29 species of brown, 32 species of green and to 5 species of blue-green. On adding to this the above-mentioned species which have the letter *c* subjoined we get 29 species (38 %) of red algæ, 47 species (70 %) of brown, 42 species (82 %) of green and 6 species (100 %) of blue-green. Thus, of the 200 species 124 prove to be common to all parts

of the coast. The percentage of each group is of the greatest importance, and for the sake of explicitness I have arranged these figures in a tabular form, both those which refer to c and those which refer to $c + (c)$.

Species common to all the coastal districts, given as percentages.

	Red algæ	Brown algæ	Green algæ	Blue-green algæ	All the groups collectively
c	20	27	19	17	22
$c + (c)$	38	70	82	100	60

On considering these two series of figures it becomes evident that the figures given for $c + (c)$ come nearer to the real facts, while those given for c merely indicate an incomplete knowledge of the coastal distribution of the species. The fact is that, where there is not a greater climatic difference between the different parts of the coast than is the case in Iceland, it may always be expected that, as regards the common species, the highest numbers will fall to the green and to the blue-green algæ; and where the hydrographic differences between the different parts of the coast are as pronounced as they are in Iceland, it is natural that the smallest number will fall to the red algæ, and just as naturally the brown algæ will in this respect be placed almost midway between the red and the green algæ.

Therefore, as regards the floristic difference between the different parts of the coast, particular stress is laid on the remaining 76 species. In the following table they are arranged according to their habitats. Under A, those species are given which either occur in E. or N. Iceland only, or are most common there, and thence are distributed southward along the north-west coast as far as SW. Iceland. Under B are given species which either have been found in S. or SW. Iceland only, or are most common there, and thence have a distribution northward along the north-west coast, many of them having, moreover, an eastward distribution along the north coast.

Table 2. The Distribution of the 76 species not common to all the coastal districts.

A	E. Icel.	N. Icel.	NW. Icel.	SW. Icel.	S. Icel.	E. Icel.	N. Icel.	NW. Icel.	SW. Icel.	S. Icel.	B
						..	..	..	..	+	1. Lomentaria clavellosa
						..	..	..	..	+	2. L. rosea
1. Lithothamnion flavescens	+	..	..	..	..	..	..	..	..	+	3. Plocamium coccineum

Table 2. The Distribution of the 76 species not common to all the coastal districts (continued).

A	E. Icel.	N. Icel.	NW. Icel.	SW. Icel.	S. Icel.	E. Icel.	N. Icel.	NW. Icel.	SW. Icel.	S. Icel.	B
<i>Omphalophyllum ulva-ceum</i>	+	..	..	..	..	..	..	..	..	?	4. <i>Bonnemaïsonia aspara-goides</i>
<i>Laminaria nigripes</i>	+	..	..	..	..	..	..	..	..	+	5. <i>Pterosiphonia parasitica</i>
<i>Acrosiphonia penicilli-formis</i>	+	..	..	..	..	..	..	..	..	+	6. <i>Rhodochorton repens</i>
<i>Delesseria Baerii</i>	?	?	..	..	..	..	..	..	..	+	7. <i>Phymatolithon polymor-phum</i>
<i>Turnerella Pennyi</i>	+	+	..	..	..	..	..	..	..	+	8. <i>Myrionema Corunnæ</i>
<i>Lithothamnion foecun-dum</i>	+	+	..	..	..	..	..	..	..	+	9. <i>Ectocarpus Hinksiae</i>
<i>Laminaria færoënsis</i> ..	+	+	..	..	..	..	..	..	..	+	10. <i>Desmarestia ligulata</i>
<i>Petroderma maculiforme</i> .	..	+	..	..	..	..	..	..	..	+	11. <i>Acrosiphonia flabelliformis</i>
<i>Ascocyclus islandicus</i> ..	..	+	..	..	..	..	..	..	..	+	12. <i>Porphyropsis coccinea</i>
<i>Dictyosiphon Mesogloia</i> ..	..	+	..	..	..	..	..	..	..	+	13. <i>Chantransia Alariæ</i>
<i>D. corymbosus</i>	..	+	..	..	..	..	..	..	..	+	14. <i>Phyllophora membrani-folia</i>
<i>Enteromorpha aureola</i> ..	..	+	..	..	..	..	..	..	..	+	15. <i>Delesseria alata</i>
<i>Ulothrix consociata</i> v. <i>is-landica</i>	..	+	..	..	..	..	..	..	..	+	16. <i>Callithamnion Arbuscula</i>
<i>Monostroma gröenlandi-cum</i>	+	+	+	..	..	..	..	..	..	+	17. <i>C. scopulorum</i>
<i>Phyllophora Brodiaei</i> v. <i>interrupta</i>	+	..	+	..	..	..	..	..	..	+	18. <i>Plumaria elegans</i>
<i>Actinococcus subcutaneus</i>	+	..	+	..	..	..	..	..	..	+	19. <i>Ceramium acanthonotum</i>
										+	20. <i>Cruoria pellita</i>
										+	21. <i>Dermatolithon macro-carpum</i>
										+	22. <i>Ectocarpus tomentosus</i>
										+	23. <i>E. fasciculatus</i>
										+	24. <i>Fucus serratus</i>
										+	25. <i>Pelvetia canaliculata</i>
										+	26. <i>Enteromorpha Linza</i>
										+	27. <i>Ceramium Deslongchamppii</i>
										+	28. <i>C. atlanticum</i>
										+	29. <i>C. fruticulosum</i>
										+	30. <i>C. circinnatum</i>
										+	31. <i>Rhodochorton minutum</i>
										+	32. <i>Dilsea edulis</i>
										+	33. <i>Lithothamnion Lenor-mandi</i>
										+	34. <i>Myrionema færoëense</i>
										+	35. <i>Dictyosiphon Ekmani</i>
										+	36. <i>Codiolum Petrocelidis</i>
										+	37. <i>Chondrus crispus</i>
										+	38. <i>Polysiphonia fastigiata</i>
										+	39. <i>Rhododerms parasitica</i>
										+	40. <i>Sphacelaria olivacea</i>
										+	41. <i>Cladophora rupestris</i>
										+	42. <i>Acrochæte repens</i>

Table 2. The Distribution of the 76 species not common to all the coastal districts (continued).

A	E. Icel.	N. Icel.	NW. Icel.	SW. Icel.	S. Icel.	E. Icel.	N. Icel.	NW. Icel.	SW. Icel.	S. Icel.	B
18. <i>Ceratocolax Hartzii</i>	..	..	+	..	..	..	+	+	+	..	43. <i>Ceramium arborescens</i>
19. <i>Polysiphonia arctica</i>	+	+	+	+	..	..	(+)	(+)	+	+	44. <i>Ahnfeltia plicata</i>
20. <i>Ptilota pectinata</i>	+	+	+	+	..	..	+	+	+	+	45. <i>Cystoclonium purpurascens</i>
21. <i>Peyssonellia Rosenvingii</i>	+	+	+	+	..	..	+	+	+	+	46. <i>Ptilota plumosa</i>
22. <i>Coilodesme bulligera</i>	+	..	+	+	..	..	+	+	..	+	47. <i>Petrocelis Henedyi</i>
23. <i>Cruoria arctica</i>	..	..	..	+	..	..	+	..	+	..	48. <i>Corallina officinalis</i>
					(+)	..	..	+	+		49. <i>Lithophyllum Crouani</i>
Total . . .	15	13	8	5	..	1	10	13	40	40	50. <i>Polysiphonia nigrescens</i>
											51. <i>Myrionema vulgare</i>
											52. <i>Leathesia difformis</i>
											53. <i>Delesseria sanguinea</i>
											Total

To illustrate more distinctly how the species with a north-eastern distribution (A) and those with a south-western distribution (B) intermingle in N., NW. and SW. Iceland I subjoin the following figures taken from the preceding table: —

	E. Icel.	N. Icel.	NW. Icel.	SW. Icel.	S. Icel.	B
	(1)	10	13	40	40	
A	15	9 + 4	8	5	..	

Notes on the species. Of the 4 species (A, 1—4, Tab. 2) which have been found only in E. Iceland, Nos. 1 and 3 occurred in great abundance in several of the fjords, while *Omphalophyllum* was found only in Reyðarfjörður, where it occurred abundantly, and *Acrosiphonia* in one place only. *Delesseria Baerii*, I suppose (31, p. 140), has originated from either E. or N. Iceland.

Turnerella is most common in E. Iceland, and in addition to the habitat in N. Iceland which has been published (31, p. 135) has been found by B. Sæmundsson in Steingrímsfjörður in the most western part of the north coast; consequently it must have a wide distribution along this coast. With regard to *Lithothamnion foecundum* and *Laminaria færoensis* it must be assumed that they are more frequent in E. and N. Iceland than is known at present, and as the latter species occurs in the Færøes, it may well be expected to be met with on other parts of the coast of Iceland.

With respect to the 6 species (A, 9—14) which have been found only in N. Iceland, it cannot be assumed that they are confined to the north coast, and it is highly probable that they have a much wider distribution on both sides. *Dictyosiphon corymbosus* and *Ulothrix consociata* v. *islandica* must, however, be assumed to belong more closely to E. and N. Iceland.

As regards the 8 species (A, 15—22) which occur so far west or south as NW. Iceland or SW. Iceland, it must be supposed that their absence from N. Iceland (and E. Iceland [*Ceratocolax*, *Cruoria*]) is due merely to insufficient knowledge regarding their distribution. Of these species, those which extend to SW. Iceland have not been found, however, further south than in Breiðfjörður, with the exception of *Peyssonellia* which has been found in Faxaflói near Reykjavík.

Of the species given under A, Nos. 1—8, 12 and 14—23 must consequently be supposed to have an east-northward distribution along the coast of Iceland, while Nos. 9, 11 and 13 must be supposed to have some other principal distribution: one species (10) is endemic in the most western part of the north coast.

Under B, 53 species are recorded. Of these 10 have been found only in S. Iceland, the majority of these in the Vestmannaeyjar only; to these must be added *Bonnemaisonia* (31, p. 141) which I believe to have been found in S. Iceland. That is, 11 species in all, one of which, however, *Rhodochorton repens*, is endemic. 17 species have been found only in S. and SW. Iceland (B, 12—28) and 8 species in SW. Iceland only. Thus, there are in all 36 species which are known from S. and SW. Iceland only. 6 species (B, 37—42) have a more northern distribution, as they have been found in NW. Iceland. Consequently, there are 42 species which are known only from S. and W. Iceland (NW. Iceland included), but of these species there are two, *Cladophora rupestris* and *Codiolum Petrocelidis* which probably have a more northern distribution. 10 species (B, 43—52) which have principally a south-western distribution (the fact that some of them have not been found in NW., SW. and S. Iceland is probably due to insufficient knowledge regarding their distribution) have been found also in N. Iceland. But all these species do not reach eastward along the north coast to the same extent, *Ptilota plumosa* and *Corallina officinalis* have been found furthest east in the eastern part of the north coast; *Lithophyllum Crouani* and *Myrionema vulgare* in Eyjafjörður; *Ahnfeltia* and *Petrocelis* extend to

Skagafjörður; while *Cystoclonium*, *Polysiphonia nigrescens* and *Leathesia* do not extend further than the most western part of the north coast (the small fjords in Húnaflói). Only *Delesseria sanguinea* now remains; strictly speaking, this appears to belong to the south and south-west coast, but has on one occasion been found in E. Iceland, cast up on the shore. It did not appear to have come from a distance, and it probably grows there, though I did not come across it in the dredgings.

Thus all these 53 species have on the whole a southern and western distribution in Iceland.

The above shows that there is a large neutral territory where the species with a south-western and those with a north-eastern distribution meet and intermingle. This boundary area comprises almost the whole of the north coast, the north-west fjords and, to a certain extent, the northern part of the south-west of the country. (For further details see below under the Floristic Boundaries.)

THE COMPONENTS OF THE ALGAL FLORA.

At present 200 species of Marine Algæ are known from Iceland. In the plant-geographical groups established by Börgesen and myself (Börgesen and Jónsson, 14) these are distributed in the following manner. The definition of the groups is here reproduced almost literally from the publication mentioned.

A. The Arctic Group.

The species of this group belong to the arctic area of the sea. The southern limit of this area extends from the north and east of Norway southward to the south-east point of Iceland, where the boundary is sharply defined. From E. Iceland the boundary line extends to the north of Iceland between Iceland and Greenland, and then turns considerably southward to the North Atlantic coast of America. The flora of the boreal area of the Atlantic passes without any distinct limit into the arctic algal flora on both sides of the Atlantic. In Iceland the limit is distinct only at the south-east point whereas the boundary is very indistinct on the north-east part of the coast.

Some of the species of this group occur, but only rarely, south of the border-zone.

Rhodophyceæ.

Ceratocolax Hartzii.	Cruoria arctica.
Turnerella Pennyi.	Lithothamnion flavescens.
Delesseria Baerii * corymbosa.	L. foecundum.
Polysiphonia arctica.	

Phæophyceæ.

Omphalophyllum ulvaceum.	Laminaria nigripes.
Dictyosiphon corymbosus.	

Chlorophyceæ.

Monostroma groenlandicum.

B. The Subarctic Group.

Subdivision I.

The species of this subdivision are common in the Arctic Sea, and are rather common in the cold-boreal area of the Atlantic Ocean as far south as the Færøes and Nordland; some of them occur, although rarely, as far south as England.

Rhodophyceæ.

Rhodophyllis dichotoma.	Peyssonellia Rosenvingii.
Halosaccion ramentaceum.	Lithothamnion tophiforme.
Ptilota pectinata.	L. læve.
Rhodochorton penicilliforme.	Clathromorphum compactum.

Phæophyceæ.

Lithoderma fatiscens.	Chætopteris plumosa.
Ralfsia ovata.	Coilodesme bulligera.
R. deusta.	Saccorrhiza dermatodea.
Myrionema globosum.	Laminaria færøensis.
M. Laminariæ.	L. digitata.
Streblonema æcidioides.	Alaria Pylaii.
Sphacelaria britannica.	

Chlorophyceæ.

Chlorochytrium Schmitzii.	U. pseudoflacca.
Monostroma undulatum.	Acrochaete parasitica.
M. fuscum.	Urospora Hartzii.
Ulothrix consociata v. islandica.	Acrosiphonia hystrix.
U. subflaccida.	A. penicilliforme.

Subdivision II.

This subdivision includes species, which are either common in the Arctic Sea and the North Atlantic from western France--England northward, or which, if not common, are at least all equally frequent.

Rhodophyceæ.

<i>Porphyra miniata.</i>	<i>Rhodymenia palmata.</i>
<i>Conchocelis rosea.</i>	<i>Delesseria sinuosa.</i>
<i>Chantransia virgatula.</i>	<i>Rhodomela lycopodioides.</i>
<i>Phyllophora Brodiaei</i> * interrupta.	<i>Odonthalia dentata.</i>
<i>Actinococcus subcutaneus.</i>	<i>Ptilota plumosa.</i>
<i>Euthora cristata.</i>	<i>Lithothamnion glaciale.</i>

Phæophyceæ.

<i>Ralfsia clavata.</i>	<i>Phæostroma pustulosum.</i>
<i>Ectocarpus tomentosoides.</i>	<i>Dictyosiphon hippuroides.</i>
<i>Leptonema fasciculatum</i> v. subcylindrica.	<i>D. foeniculaceus.</i>
<i>Elachista fucicola.</i>	<i>Desmarestia viridis.</i>
<i>Punctaria plantaginea.</i>	<i>D. aculeata.</i>
<i>Litosiphon filiformis.</i>	<i>Chordaria flagelliformis.</i>
<i>Isthmoplea sphærophora.</i>	<i>Chorda tomentosa.</i>
<i>Stictyosiphon tortilis.</i>	<i>C. filum.</i>
	<i>Fucus inflatus.</i>

Chlorophyceæ.

<i>Chlorochytrium Cohnii.</i>	<i>Pringsheimia scutata.</i>
<i>C. inclusum.</i>	<i>Urospora mirabilis.</i>
<i>C. dermatocolax.</i>	<i>U. Wormskioldii.</i>
<i>Codiolum gregarium.</i>	<i>Chætomorpha Melagonium.</i>
<i>Percursaria percursa.</i>	<i>Spongomorpha vernalis.</i>
<i>Monostroma Grevillei.</i>	<i>Acrosiphonia incurva.</i>
<i>Ulothrix flacca.</i>	<i>Cladophora rupestris.</i>
<i>Pseudendoclonium submarinum.</i>	<i>C. hirta.</i>
<i>Bolbocoleon piliferum.</i>	<i>C. sericea.</i>
<i>Ulvella fucicola.</i>	<i>Ostreobium Queketti.</i>

Cyanophyceæ.

Pleurocapsa amethystea.

C. The Boreal-Arctic Group.

The species of this group are common in the Arctic Sea and the boreal area of the Atlantic at least as far south as the Atlantic coast of North Africa; probably some of them have a far greater southern distribution. Some of them might possibly be considered cosmopolitan.

Rhodophyceæ.

<i>Bangia fuscopurpurea.</i>	<i>Antihamnion Plumula</i> v. boreale.
<i>Porphyra umbilicalis.</i>	<i>Ceramium rubrum.</i>
<i>Chantransia microscopica.</i>	<i>Rhodochorton Rothii.</i>
<i>C. secundata.</i>	<i>R. membranaceum.</i>
<i>Ahnfeltia plicata.</i>	<i>Hildenbrandia rosea.</i>

Phæophyceæ.

<i>Pylaiella littoralis.</i>	<i>Phyllitis fasciæ.</i>
<i>Ectocarpus confervoides.</i>	<i>Fucus vesiculosus.</i>
<i>E. siliculosus.</i>	<i>Ascophyllum nodosum.</i>
<i>Scytosiphon Lomentaria.</i>	

Chlorophyceæ.

<i>Enteromorpha intestinalis.</i>	<i>Rhizoclonium riparium.</i>
<i>E. clathrata.</i>	<i>Cladophora gracilis.</i>
<i>Ulva lactuca.</i>	<i>Gomontia polyrrhiza.</i>
<i>Chætomorpha tortuosa.</i>	

Cyanophyceæ.

<i>Spirulina subsalsa.</i>	<i>Rivularia atra.</i>
<i>Calothrix scopulorum.</i>	

D. The Cold-Boreal Group.

The species of this group have their area of distribution from western France—England northward to S. Iceland, the Færøes and Nordland—Finmark. Some few species have occasionally been found in the Arctic Sea, especially in the White Sea and the Murman Sea, and some few reach as far south as the Mediterranean and North Africa.

Rhodophyceæ.

<i>Porphyropsis coccinea.</i>	<i>Ceramium fruticulosum.</i>
<i>Chantransia Alariæ.</i>	<i>C. circinnatum.</i>
<i>Gigartina mamilliosa.</i>	<i>C. altanticum.</i>
<i>Phyllophora membranifolia.</i>	<i>Rhodochorton repens.</i>
<i>Cystoclonium purpurascens.</i>	<i>R. minutum.</i>
<i>Lomentaria rosea.</i>	<i>Dumontia filiformis.</i>
<i>Delesseria alata.</i>	<i>Dilsea edulis.</i>
<i>D. sanguinea.</i>	<i>Petrocelis Henedyi.</i>
<i>Polysiphonia urceolata.</i>	<i>Rhododermis parasitica.</i>
<i>P. fastigiata.</i>	<i>Lithothamnion Unger.</i>
<i>P. nigrescens.</i>	<i>L. Lenormandi.</i>
<i>Callithamnion Arbuscula.</i>	<i>Phymatolithon polymorphum.</i>
<i>Plumaria elegans.</i>	<i>Lithophyllum Crouani.</i>
<i>Antithamnion floccosum.</i>	<i>Dermatolithon macrocarpum.</i>
<i>Ceramium acanthonotum.</i>	<i>Corallina officinalis.</i>
<i>C. Deslongchampii.</i>	

Phæophyceæ.

<i>Petroderma maculiforme.</i>	<i>Ascocyclus islandicus.</i>
<i>Ralfsia verrucosa.</i>	<i>Microsyphar Polysiphoniæ.</i>
<i>Myrionema vulgare.</i>	<i>Streblonema Stilophoræ v. cæspitosa.</i>
<i>M. Corunnæ.</i>	<i>Ectocarpus tomentosus.</i>
<i>M. færøense.</i>	<i>E. penicillatus.</i>

Ectocarpus fasciculatus.
E. Hinksiae.
Sphacelaria radicans.
S. olivacea.
Phyllitis zosterifolia.
Dictyosiphon Ekmani.
D. Mesogloia.
D. Chordaria.

Castagnea virescens.
Laminaria saccharina.
L. hyperborea.
Fucus spiralis.
F. serratus.
Pelvetia canaliculata.
Alaria esculenta.

Chlorophyceæ.

Codiolum Petrocelidis.
C. pusillum.
Enteromorpha aureola.
Prasiola polyrrhiza.
P. furfuracea
P. stipitata.

Entoderma Wittrockii.
Acrochæte repens.
Ochlochæte ferox.
Acrosiphonia albescens.
A. flabelliformis.
Cladophora glaucescens.

Cyanophyceæ.

Plectonema norvegicum.

E. The Warm-Boreal Group.

The majority of the species referred to this group extend at least as far south as the Mediterranean and the Atlantic coast of North Africa. According to the different distribution northward the group is divided into three parts of which only the one reaches as far north as S. Iceland.

1. Species extending as far north as S. Iceland, the Færøes and Northern Norway, and at least as far south as the Mediterranean and North Africa.

Rhodophyceæ.

Chondrus crispus.
Lomentaria clavellosa.
Plocamium coccineum.
Bonnemaïsonia asparagoides.
Pterosiphonia parasitica.

Callithamnion scopulorum.
Ceramium arborescens.
Cruoria pellita.

Phæophyceæ.

Desmarestia ligulata.

Leathesia difformis.

Chlorophyceæ.

Enteromorpha Linza.

Cyanophyceæ.

Phormidium autumnale.

According to the above the number of species in the groups is as follows: —

	Rhodo- phyceæ	Phæo- phyceæ	Chloro- phyceæ	Cyano- phyceæ	
1. The arctic group.....	7	3	1	•	= 11 species (5.5%)
2. The subarctic group:					
Subdivision I.....	8	13	10	•	= 31 — (15.5%)
3. The subarctic group:					
Subdivision II.....	12	17	20	1	= 50 — (25.0%)
4. The boreal-arctic group	10	7	7	3	= 27 — (13.5%)
5. The cold-boreal group.	31	25	12	1	= 69 — (34.5%)
6. The warm-boreal group	8	2	1	1	= 12 — (6.0%)
	76	67	51	6	

If we divide the six groups into two parts, A: the first three groups, and B: the last three¹ groups, we obtain the following figures: —

A, 92 species (46 %) and B, 108 species (54 %).

The floral district must therefore be determined as boreal, because more than half of the species belong to the last three groups. Of these groups the cold-boreal is the most important because its species form 64 % of the total number of species (108) in all three groups. This floral district has not, however, a purely boreal character, as the subarctic group is rich in species and gives a rather high percentage (41 %). The floral district, then, is characterized to a very high degree by a boreal element, and next by a subarctic element.

If we consider only the red and the brown algæ, 143 species in all, the cold-boreal character is a little more strongly pronounced than the subarctic. The figures are: — Arctic 10 species (7 %), subarctic 50 species (35 %), boreal-arctic 17 species (12 %), cold-boreal 56 species (39 %) and warm-boreal 10 species (7 %). The first three groups have 60 species (42 %), the last three 78 species (58 %).

If we compare the five divisions of the coast with respect to the number of species in the different groups, we obtain the figures given in Tables 3, 4.

If, for instance, we select the red and the brown algæ (Table 4) as a basis, then the difference which exists in the different parts of the coast is very evident. In E. Iceland the arctic group contains the greatest number of species, and this number — if we follow the divisions of the coast in the order of the tables — decreases

¹ The boreal-arctic group is included in the boreal groups, as its species, though common in the arctic district, have a far larger area of distribution outside this.

Table 3. Red algæ, Brown algæ, Green algæ, Blue-green algæ collectively.

	E. Icel.		N. Icel.		NW. Icel.		SW. Icel.		S. Icel.	
	Number of species	%	Number of species	%	Number of species	%	Number of species	%	Number of species	%
Arctic group.....	8	7	5	4	3	3	2	1	»	»
Subarctic group I.....	25	22	24	20	16	17	27	18	12	11
Subarctic group II.....	38	34	37	30	39	41	44	28	28	26
Boreal arctic group....	20	18	26	21	16	17	23	15	16	15
Cold-boreal group.....	20	18	29	24	18	20	53	34	43	39
Warm-boreal group....	1	c. 1	2	c. 1	2	c. 2	6	4	9	9
Total...	112		123		94		155		108	

Table 4. Red and Brown algæ collectively.

	E. Icel.		N. Icel.		NW. Icel.		SW. Icel.		S. Icel.	
	Number of species	%	Number of species	%	Number of species	%	Number of species	%	Number of species	%
Arctic group.....	7	9	4	5	2	3	2	2	»	»
Subarctic group I.....	18	23	19	22	13	18	20	17	8	10
Subarctic group II.....	25	31	24	28	27	37	26	23	17	20
Boreal arctic group....	13	16	17	19	13	18	16	14	13	15
Cold-boreal group.....	17	21	21	24	16	22	46	40	38	45
Warm-boreal group....	»	»	2	2	2	2	5	4	8	10
Total...	80		87		73		115		84	

uniformly in the other parts of the coast, and is reduced to 0 in S. Iceland. In E., N., NW. and SW. Iceland the number of the species in the subarctic group I is practically identical in proportion to the number of species, taken as a whole, in these parts of the coast; S. Iceland has a distinctly smaller number, only 10 %. The subarctic group II is represented most abundantly in NW. Iceland; E. and N. Iceland come next; but S. and SW. Iceland have a considerably lower percentage (about 20 %). The percentage in the boreal-arctic group is practically identical in all parts of the coast. The cold-boreal group presents almost the same percentage in E., N. and NW. Iceland, while the percentage in the group in

SW. and S. Iceland is almost double this. The warm-boreal group is not represented in E. Iceland, and only with extreme rarity (1 species) in N. and NW. Iceland. SW. Iceland has only 4 species, while S. Iceland has 8 (10 %).

There is a very great similarity between S. Iceland and SW. Iceland, if the arctic group in SW. Iceland is excluded; on the other hand, the difference is greatest between E. Iceland and S. Iceland, as is shown by the following figures: —

	East Iceland	South Iceland
Arctic group.....	9 %	0 %
Subarctic groups.....	54 %	30 %
Boreal-arctic group	16 %	15 %
Cold-boreal group	21 %	45 %
Warm-boreal group.....	0 %	10 %

If we assume that the species marked (c) (Table 1) are to be considered as common to all parts of the coast (see above), the distribution of the 76 not-common species becomes decisive with reference to the floristic difference between the parts of the coast. In the following table, therefore, it is shown how these 76 species are arranged in the six plant-geographical groups of algæ.

Table 5. Group-division of the 76 not-common species (see Table 2).

A	E. Icel.	N. Icel.	NW.Icel.	SW.Icel.	S. Icel.	B
Arctic group	8	5	3	2	..	Arctic group.
Subarctic group I	5	4	3	3	..	Subarctic group I.
Subarctic group II....	..	1	2	2	2	Subarctic group II.
Boreal-arctic group ...	..	1	1	1	1	Boreal-arctic group.
Cold-boreal group	1	6	8	31	28	Cold-boreal group.
Warm-boreal group....	..	4	..	..	..	Warm-boreal group.
Total number of species	15	9 + 4	8	5	..	Total number of species
	16	23	21	45	40	

The figures in this table show what has been already shown by those which I have given in Tables 3 and 4; but the arctic

element in E. Iceland and the boreal element in S. and SW. Iceland are much more sharply defined; and this is natural, as the species assumed to be common are omitted. Even if we consider only the known distribution of the species, in its entirety (see Table 1), the distribution of the here-mentioned 76 species will still be the most essential reason for the floristic difference between the parts of the coast.

The species assumed to be common are 124 (see above). Of these none are arctic, 25 belong to the subarctic group I, 46 to the subarctic group II, 26 are boreal-arctic, 26 cold-boreal, and one (*Phormidium autumnale*) is warm-boreal. Of the 76 not-common species, 11 are arctic, 6 belong to the subarctic group I, 4 to the subarctic group II, one (*Ahnfeltia plicata*) is boreal-arctic, 43 are cold-boreal and 11 warm-boreal. If we add together the numbers representing the species of the corresponding groups as regards the 124 species assumed to be common and the 76 not-common species (Table 5), and compare with Table 3, we find that the species are more numerous in each district, but that the percentages are almost the same.

If the groups are divided in two parts, A and B (see above) so that A includes the arctic and subarctic groups, and B the three other groups, the following figures are obtained (see Table 4): —

	E. Icel.	N. Icel.	NW. Icel.	SW. Icel.	S. Icel.
A	50 (63 0/0)	47 (54 0/0)	42 (58 0/0)	48 (42 0/0)	25 (30 0/0)
B	30 (37 0/0)	40 (46 0/0)	31 (42 0/0)	67 (58 0/0)	59 (70 0/0)

The arctic group is poorly represented in all the districts of the coast (see Table 4) and therefore the figures mentioned above under A apply chiefly to the subarctic group; the floral districts of E. Iceland, N. Iceland and NW. Iceland are thus subarctic. E. Iceland is subarctic to a greater extent than N. and NW. Iceland. SW. Iceland is a boreal floral district with a very considerable subarctic element, and thus resembles the coasts of Iceland taken as a whole (see above). S. Iceland is a boreal district with a slightly subarctic element.

Floristic Boundaries.

The mixed character of the flora in N. and NW. Iceland has been alluded to several times in the foregoing pages, and is clearly seen from the tables given, as, for example, Tables 2 and 5. Here,

neither, is any distinct boundary found between the boreal and subarctic floral districts, and the north and north-west of the country must, strictly speaking, be considered a large boundary-area, a view which accords well, also, with the hydrographic conditions. Here, the boreal, subarctic and arctic species intermingle.

At the south-eastern point of Iceland there is, on the other hand, a rather distinct hydrographic boundary along the stretch from Vestrahorn to Eystrahorn (or Lónsheiði). The greater part of this coast is sandy, and difficult of access for the investigation of the algal vegetation. From my own observations I can only say that Berufjörður, the most southerly point in E. Iceland which I have examined with regard to its algal vegetation, has a cold-water flora, and that the Vestmannaeyjar, the most easterly locality on the south coast which I have examined for the same purpose, have a warm-water flora. The boundary must lie between them, and I conclude, especially from the hydrographic conditions and the distribution of the Plankton-associations, that it is situated just on the stretch of coast already mentioned. Ove Paulsen (55 and 56) has given valuable information respecting this boundary, and it is evident from his investigations that the boundary varies to a slight extent, the facts being that in May-June it has been found in the vicinity of Eystrahorn (see 55, map I), but in July-August at Vestrahorn (see 55, map II). If algæ grow on this stretch of coast, one may conclude that there exists a mixed flora resembling that of N. and NW. Iceland. Whether boreal species can be carried to E. Iceland in this manner is at present not easy to say with certainty, yet it seems to me that the occurrence of *Dumontia filiformis* and *Delesseria sanguinea*, both of which are absent in N. and NW. Iceland, can be most easily explained in this way.

IV. COMPARISON WITH NEIGHBOURING FLORAL DISTRICTS.

IN Table 6¹ is given a survey of the plant-geographical distribution of red and brown algæ collectively, in certain subarctic and boreal floral districts. These are so arranged that those floras with the largest arctic element stand furthest to the left. The arctic and subarctic percentages decrease while the boreal percentage increases to the right. The boreal-arctic group is practically similar everywhere, which is also natural according to the geographical distribution of the group. The warm-boreal group is not represented in the subarctic floras, and the arctic group is quite infinitesimal in SW. Iceland and Nordland, and is entirely absent from S. Iceland and the Færøes. In regard to species, the cold-boreal group is extremely poor in East Greenland and Spitzbergen, somewhat richer in West Greenland and considerably richer in E. Iceland.

By grouping the species, as is done above (cf. Børgesen and Jónsson, 14), the character of the floral districts can be determined according to those groups which are richest in species. Thus, I characterize a group as subarctic when more than half of its species are reckoned to the subarctic group. In a similar manner a district is boreal when more than half of its species belong to the boreal groups (bor. arct., cold-bor., and warm-bor.).

Similarly, in an arctic district the species belonging to the arctic group must constitute more than half of the number of species belonging to the district, and, in addition to the subarctic group, only the boreal-arctic will be represented. Of the floral districts mentioned by Børgesen and Jónsson (14) none are arctic according

¹ With the exception of Iceland the numbers of the species of red and brown algæ are taken from Børgesen and Jónsson l. c. (14, p. 22). In regard to East Greenland the numbers are corrected according to Rosenvinge (64), and to West Greenland two species have been added: *Ectocarpus maritimus* and *Chantransia collopoda*.

to the definition here employed. The Siberian Sea, however, comes nearest to it. From here 23 species are known (14), of which 9 (39 %) are arctic, 11 (48 %) subarctic and 3 (13 %) boreal-arctic. This district is at the boundary between arctic and subarctic. Regarded superficially it may appear strange that none of the districts are arctic, but on closer inspection this is easily understood, the reason being that some of the districts (14) are too large and consequently acquire a mixed character. In this respect I shall merely point out, for instance, that both Spitzbergen and East Greenland (and probably West Greenland) ought to be divided into two districts.

As already mentioned, none of the districts recorded in Table 6 is arctic. East Greenland, Spitzbergen and West Greenland have almost the same percentage as regards the arctic species (Table 6), and as this percentage is rather high in proportion to that of the boreal species, these districts could be termed arctic-subarctic, in contradistinction to E. Iceland where the arctic percentage is four times less than the percentage of the boreal species. The boreal districts recorded here (Table 6, p. 70) should, strictly speaking, be called cold-boreal.

If we call the first three groups (in Table 6) A and the three last B the percentages will be as follows: —

	E. Greenl.	Spitzb.	W.Greenl.	E. Icel.	Finn.	SW. Icel.	S. Icel.	Fær.	Nordl.
A.....	81	77	72	63	46	42	30	29	27
B.....	19	23	28	37	54	58	70	71	73

As the table shows, SW. Iceland agrees most closely with Finmark, while S. Iceland and the Færøes are nearly alike, as Børgeesen (12, p. 804) also supposes.

If we take Iceland as a whole, we get 143 species (red and brown algæ collectively), 10 (7 %) arctic, 21 (15 %) subarctic (subdivision I), 29 (20 %) subarctic (subdivision II), 17 (12 %) boreal-arctic, 56 (39 %) cold-boreal and 10 (7 %) warm-boreal. These figures are almost the same as those given for Finmark (see Table 6) and differ, essentially from the figures given for SW. Iceland, only by the higher percentage of arctic and warm-boreal species. If, on the other hand, we take the first three groups collectively and the three last groups in a similar manner, we obtain the same percentages as for SW. Iceland. On combining different parts of the coast, as for instance, E. Iceland and N. Iceland, we get almost the

Table 6. Distribution in groups of Red and Brown algae collectively in certain Subarctic and Boreal floral districts.

	East Greenland.		Spitzbergen.		West Greenland. ¹		E. Icel.		Finnmark		SW. Icel.		S. Icel.		Færøes. ¹		Norland	
	Number of species	%	Number of species	%	Number of species	%	Number of species	%	Number of species	%	Number of species	%	Number of species	%	Number of species	%	Number of species	%
Arctic group.....	15	18	10	17	20	18	7	9	7	6	2	2	..	..	..	..	1	1
Subarctic group I.....	26	30	14	23	27	26	18	23	21	17	20	17	8	10	14	9	12	10
Subarctic group II.....	28	33	22	37	31	28	25	31	29	23	26	23	17	20	31	20	20	16
Subarctic group I + II....	54	63	36	60	58	54	43	54	50	40	46	40	25	30	45	29	32	26
Boreal-arctic group.....	12	14	9	15	17	16	13	16	18	14	16	14	13	15	17	11	16	13
Cold-boreal group.....	4	5	5	8	13	12	17	21	45	36	46	40	38	45	75	47	61	49
Warm-boreal group.....	..	..	..	..	..	..	..	..	5	4	5	4	8	10	20	13	13	11
Total...	85		60		108		80		125		115		84		157		123	

Subarctic

Boreal

¹ According to Petersen (57) 2 species of *Ceramium* (*C. Areschougii* assigned to the subarctic group II and *C. septentrionale* assigned to the arctic group) have been added to West Greenland. To the Færøes have been added *Ceramium Boergesenii* and *Ceramium atlanticum*, both of which I assign to the cold-boreal group.

same figures as for E. Iceland, and on combining NW., SW. and S. Iceland we get almost the same figures as for SW. Iceland. E. Iceland and N. Iceland have 101 species of red and brown algæ collectively. Of these 8 (8 %) are arctic, 20 (20 %) subarctic (subdivision I), 28 (27 %) subarctic (subdivision II), 17 (17 %) boreal-arctic, 26 (26 %) cold-boreal and 2 (2 %) warm-boreal. NW., SW. and S. Iceland have 131 species of red and brown algæ collectively. Of these 3 (2 %) are arctic, 20 (15 %) subarctic (subdivision I), 29 (22 %) subarctic (subdivision II), 16 (12 %) boreal-arctic, 53 (41 %) cold-boreal and 10 (8 %) warm-boreal.

As regards the components of the flora, both Iceland taken as a whole, and SW. Iceland resemble Finmark; S. Iceland resembles the Færøes and Nordland, and E. Iceland resembles the White Sea.¹

It is evidently not due to chance that the resemblance of the floral districts happens thus. The situation of Iceland just south of and at the boundary between the arctic and the cold-boreal districts corresponds exactly with the situation of Nordland—Finmark—White Sea in relation to this boundary. Iceland and the White Sea are at the boundary itself, and in Finmark it certainly will be possible to distinguish parts of the coast with a similar mixed flora as in N. and NW. Iceland; the southern part of Finmark will then be something like SW. Iceland, while S. Iceland, as already mentioned, corresponds with Nordland.

This comparison shows only the relation between the quantity of the species of the floral districts within the different groups, but gives no information as to how far the species are common to all those districts. Then it remains to be investigated how many species Iceland has in common with the other districts. At the present time a comparison of the floras will, however, scarcely give any satisfactory results, because all the districts in question are not equally well-known. By future investigations a greater number of species will unquestionably be found in the majority of the floral districts, and the quantity of the species will thus be altered, but the relation between the number of the species of the different groups will, however, undoubtedly remain unaltered.

¹ According to Börgesen and Jónsson (14) 52 species are known from the White Sea, of which 3 (6 %) are arctic, 10 (19 %) subarctic (subdivision I), 19 (37 %) subarctic (subdivision II), 8 (15 %) boreal-arctic and 12 (23 %) cold-boreal. The subarctic species constitute 56 % of the entire number of species and the character of the flora is consequently subarctic in the same degree as that of E. Iceland.

If we compare S. Iceland and the Færøes with regard to common species, the following figures are obtained: —

South Iceland 84 species ¹		The Færøes 157 species
not common	common	not common
10 (6 %)	74 (44 %)	83 (50 %)

Here it should be noted that S. Iceland is so very little known that one is scarcely justified in comparing it with such a well investigated district as the Færøes. Many of the species which in this respect are peculiar to the Færøes will certainly be found in S. Iceland and, at any rate, 32 of them are known from other parts of Iceland, principally from SW. Iceland.

If we choose a larger district of the coast of Iceland, for instance, the boreal district (S. Iceland and SW. Iceland) for comparison with the Færøes, the following figures will be obtained: —

S. and SW. Iceland 126 species		The Færøes 157 species
not common	common	not common
25 (14 %)	101 (55 %)	56 (31 %)

On comparing Iceland with the Færøes we obtain the following figures: —

Iceland 143 species		The Færøes 157 species
not common	common	not common
37 (19 %)	106 (55 %)	51 (26 %)

The 37 species which grow in Iceland and are absent from the Færøes are the following: —

† <i>Chantransia microscopica</i> .	† <i>Petrocelis Hennedyi</i> .
<i>Ceratocolax Hartzii</i> .	<i>Cruoria arctica</i> .
<i>Turnerella Pennyi</i> .	† <i>Peyssonellia Rosenvingii</i> .
<i>Delesseria Baerii</i> .	† <i>Rhododermis parasitica</i> .
<i>Bonnemaïsonia asparagoides</i> . ²	<i>Lithothamnion flavescens</i> .
<i>Polysiphonia arctica</i> .	<i>L. foecundum</i> .
<i>Ceramium Deslongchampsii</i> .	† <i>L. tophiforme</i> .
<i>C. fruticosum</i> .	† <i>L. Ungerii</i> .
<i>C. circinnatum</i> .	† <i>Ralfsia ovata</i> .
<i>C. arborescens</i> .	<i>R. deusta</i> .
† <i>Rhodochorton minutum</i> .	† <i>Myrionema Laminariæ</i>
† <i>R. repens</i> .	† <i>Ascocyclus islandicus</i> .
† <i>Dilsea edulis</i> .	† <i>Ectocarpus penicillatus</i> .

¹ These and the following figures apply to red and brown algæ collectively.

² I attach no importance to the fact of this species having occurred in Iceland, as it has not yet been found again.

† <i>Sphacelaria radicans</i> .	† <i>Dictyosiphon Chordaria</i> .
† <i>S. olivacea</i> .	<i>D. corymbosus</i> .
<i>Omphalophyllum ulvaceum</i> .	<i>Saccorrhiza dermatodea</i> .
† <i>Phæostroma pustulosum</i> .	<i>Laminaria nigripes</i> .
<i>Coilodesme bulligera</i> .	† <i>Fucus serratus</i> .
† <i>Dictyosiphon Mesogloia</i> .	

Which of these species may be found in the Færøes is not easy to decide (cf. also Børgesen, 12, p. 795). But it does not appear altogether improbable that 19 species (marked with a † before the name) could occur there.

The 51 Færøese species which are not found in Iceland are the following: —

† <i>Erythrotrichia ceramicola</i> .	† <i>Rhododermis elegans</i> .
† <i>Porphyra leucosticta</i> .	<i>Phymatolithon lævigatum</i> .
† <i>Chantransia efflorescens</i> .	<i>Lithophyllum incrustans</i> .
† <i>C. Daviesii</i> .	<i>L. hapalidioides</i> .
<i>Choreocolax Polysiphoniae</i> .	† <i>Sorapion Kjellmani</i> .
† <i>Harveyella mirabilis</i> .	† <i>Myrionema foecundum</i> .
<i>Callophyllis laciniata</i> .	† <i>M. speciosum</i> .
<i>Callocolax neglectus</i> .	† <i>Chilionema reptans</i> .
<i>Sterrocolax decipiens</i> .	<i>Microsyphar Zosteræ</i> .
† <i>Lomentaria articulata</i> .	<i>Ectocarpus velutinus</i> .
<i>Nitophyllum laceratum</i> .	† <i>E. lucifugus</i> .
<i>Laurencia pinnatifida</i> .	<i>E. dasycarpus</i> .
<i>Polysiphonia violacea</i> .	<i>E. granulatus</i> .
† <i>P. Brodiaei</i> .	<i>Elachista scutulata</i> .
† <i>P. elongata</i> .	<i>Sphacelaria cæspitula</i> .
<i>P. atrorubescens</i> .	<i>S. furcigera</i> .
<i>Rhodomela subfusca</i> .	† <i>S. cirrhosa</i> .
<i>Griffithsia setacea</i> .	<i>Cladostephus spongiosus</i> .
† <i>Callithamnion polyspermum</i> .	<i>Desmotrichum undulatum</i> .
† <i>C. corymbosum</i> .	<i>Punctaria latifolia</i> .
<i>C. granulatum</i> .	† <i>Asperococcus echinatus</i> .
† <i>Ceramium Boergesenii</i> .	† <i>Litosiphon Laminariæ</i> .
<i>Rhodochorton seiriolanum</i> .	† <i>Phæostroma parasiticum</i> .
† <i>Furcellaria fastigiata</i> .	† <i>Himanthalia lorea</i> .
† <i>Polyides rotundus</i> .	† <i>Halidrys siliquosa</i> .
† <i>Cruoriella Dubyi</i> .	

Possibly many of these species, perhaps almost half of them, are to be found in S. and SW. Iceland. The 26 species marked with a † before the name may possibly be found in Iceland, though with many of them this is doubtful.

If it should appear from further investigations that some of the species considered not common to the Færøes and Iceland are common to them, it should not be assumed from this that the floristic

resemblance is increased, as it is highly probable that other species which are not common would be simultaneously found.

From the coast of Norway I select Finmark for comparison with Iceland, which comparison gives the following figures: —

Iceland 143 species		Finmark 125 species	
not common	common	not common	
45 (26 %)	98 (58 %)	27 (16 %)	

A comparison between Finmark and SW. Iceland gives the following figures: —

SW. Iceland 115 species		Finmark 125 species	
not common	common	not common	
29 (19 %)	86 (56 %)	39 (25 %)	

The following are the 45 species which are found in Iceland and are absent from Finmark: —

1 <i>Porphyropsis coccinea</i> .	24 <i>Ralfsia ovata</i> .
2 <i>Chantransia Alariæ</i> .	25 <i>R. clavata</i> .
3 <i>Phyllophora membranifolia</i> .	26 <i>R. verrucosa</i> .
4 <i>Ceratocolax Hartzii</i> .	27 <i>Myrionema Lamimariæ</i> .
5 <i>Lomentaria rosea</i> .	28 <i>M. Corunnæ</i> .
6 <i>L. clavellosa</i> .	29 <i>M. globosum</i> .
7 <i>Plocamium coccineum</i> .	30 <i>M. færøense</i> .
8 <i>Delesseria Baerii</i> .	31 <i>Ascocyclus islandicus</i> .
9 <i>Bonnemaisionia asparagoides</i> .	32 <i>Microsyphar Polysiphoniæ</i> .
10 <i>Pterosiphonia parasitica</i> .	33 <i>Ectocarpus Stilophoræ</i> .
11 <i>Callithamnion Arbuscula</i> .	34 <i>E. tomentosoides</i> .
12 <i>Ceramium acanthotum</i> .	35 <i>E. tomentosus</i> .
13 <i>C. fruticosum</i> .	36 <i>E. Hinksia</i> .
14 <i>C. arborescens</i> .	37 <i>Sphacelaria radicans</i> .
15 <i>C. atlanticum</i> .	38 <i>S. olivacea</i> .
16 <i>Rhodochorton minutum</i> .	39 <i>Omphalophyllum ulvaceum</i> .
17 <i>R. repens</i> .	40 <i>Litosiphon filiformis</i> .
18 <i>Dilsea edulis</i> .	41 <i>Phæostroma pustulosum</i> .
19 <i>Petrocelis Henedyi</i> .	42 <i>Phyllitis zosterifolia</i> .
20 <i>Cruoria arctica</i> .	43 <i>Dictyosiphon Mesogloia</i> .
21 <i>C. pellita</i> .	44 <i>Desmarestia ligulata</i> .
22 <i>Rhododermis parasitica</i> .	45 <i>Laminaria færøensis</i> .
23 <i>Petroderma maculiforme</i> .	

Of these species ten (Nos. 3, 6, 7, 10, 11, 12, 18, 21, 26 and 35) are known from Nordland and therefore might possibly be found also in Finmark. Furthermore, nine of the species (Nos. 2, 5, 9, 25, 33, 34, 35, 40, 44) are known from West Norway, and the majority of these will also be found, without doubt, in Nordland and Fin-

mark. Of the remaining 23 species the greater number will certainly be found in Finmark. But I think it less probable that *Omphalophyllum ulvaceum* and *Laminaria færoënsis* are to be met with there, while one can form no opinion as to whether the endemic Icelandic species (17 and 31) exist in Finmark, as their distribution outside Iceland is unknown. On the other hand I think it somewhat probable that the Icelandic-Færøese species *Myrionema færoëse* may occur in Finmark.

The 27 species, which are present in Finmark and absent from Iceland, are the following: —

Chantransia efflorescens.	Ectocarpus terminalis.
C. Daviesii.	E. nanus.
Harveyella mirabilis.	E. ovatus.
Polysiphonia elongata.	Myriotrichia filiformis.
Spermothamnion Turneri.	Sphacelaria racemosa.
Furcellaria fastigiata.	S. cirrhosa.
Polyides rotundus.	Phæosaccion Collinsii.
Petrocelis Middendorffii.	Asperococcus echinatus.
Phymatolithon investiens.	Delamarea attenuata.
Lithothamnion intermedium.	Dictyosiphon hispidus.
L. fornicatum.	Laminaria Agardhii.
Lithoderma lignicola.	Haplospora globosa.
Myrionema foecundum.	Halidrys siliquosa.
Chilionema reptans.	

The majority of these species may be expected to occur on the coasts of Iceland, but there is less probability of *Laminaria Agardhii* being met with there.

If we turn to E. Iceland and compare this with the White Sea we obtain the following figures: —

E. Iceland 80 species		White Sea 52 species	
not common	common	not common	
43 (45 %)	37 (39 %)	15 (16 %)	

The floristic similarity is somewhat considerable, and ten of the species peculiar to the White Sea are known from other parts of the coast of Iceland. These ten species are *Dilsea edulis*, *Cystoclonium purpurascens*, *Polysiphonia nigrescens*, *Delesseria alata*, *Ptilota plumosa*, *Lithothamnion Lenormandi*, *Corallina officinalis*, *Dictyosiphon hippuroides*, *Fucus serratus*, and *Pelvetia canaliculata*.

Of these species, however, only an extremely small number can be expected to occur in E. Iceland.

The five species present in the White Sea and entirely absent from Iceland are: —

Chantransia efflorescens.
Furcellaria fastigiata.
Polyides rotundus.

Sphacelaria racemosa.
Laminaria Agardhii.

With the exception of *Laminaria Agardhii* all these species certainly may be met with on the coasts of Iceland, but in E. Iceland one can scarcely expect to find others than *Chantransia efflorescens* and *Sphacelaria racemosa*.

If we compare Iceland and E. Iceland with West Greenland and East Greenland we get the following figures: —

Iceland 143 species		West Greenland 108 species	
not common	common	not common	
62 (36 %)	81 (48 %)	27 (16 %)	
Iceland 143 species		East Greenland 85 species	
not common	common	not common	
79 (48 %)	64 (39 %)	21 (13 %)	
E. Iceland 80 species		West Greenland 108 species	
not common	common	not common	
11 (9 %)	69 (58 %)	39 (33 %)	
E. Iceland 80 species		East Greenland 85 species	
not common	common	not common	
23 (21 %)	57 (53 %)	28 (26 %)	

The species present in Iceland and absent from West Greenland are the following: —

Porphyropsis coccinea.
Chantransia Alariæ.
Phyllophora membranifolia.
Ahnfeltia plicata.
Chondrus crispus.
Gigartina mamilliosa.
Cystoclonium purpurascens.
Lomentaria rosea.
L. clavellosa.
Plocamium coccineum.
Delesseria alata.
D. sanguinea.
Bonnemaïsonia asparagoides.
Polysiphonia fastigiata.
P. nigrescens.
Pterosiphonia parasitica.
Odonthalia dentata.
Callithamnion scopulorum.
C. Arbuscula.
Plumaria elegans.

Ptilota plumosa.
Ceramium acanthotum.
C. Deslongchampsii.
C. fruticulosum.
C. circinnatum.
C. arborescens.
C. atlanticum.
Rhodochorton minutum.
R. repens.
Dumontia filiformis.
Dilsea edulis.
Petrocelis Henedyi.
Cruoria pellita.
Rhododermis parasitica.
Phymatolithon polymorphum.
Lithothamnion Lenormandi.
L. flavescens.
L. Ungerii.
Lithophyllum Crouani.
Dermatolithon macrocarpum.

Corallina officinalis.	Dictyosiphon Ekmanni.
Petroderma maculiforme.	D. Mesogloia.
Myrionema Laminariæ (in E. Greenl.)	Desmarestia ligulata.
M. vulgare.	Leathesia difformis.
M. Corunnæ.	Laminaria saccharina (in E. Greenl.)
M. færøense.	L. færøensis.
Ascocyclus islandicus.	L. hyperborea.
Ectocarpus tomentosus.	Alaria esculenta (in E. Greenl.)
E. fasciculatus.	Fucus spiralis.
E. Hinksii.	F. serratus.
Sphacelaria olivacea.	Pelvetia canaliculata.

Of the 57 species here mentioned three are found in East Greenland; viz. *Myrionema Laminariæ*, *Laminaria saccharina* and *Alaria esculenta*. It is most probable that none of these 57 species will be met with in West Greenland, with the exception, perhaps, of some of the *Myrionema*-species.

There are 74 species absent from East Greenland which are found in Iceland. Of these, 54 species have already been mentioned (see above), and to these must be added 20 species which are absent from East Greenland but present in West Greenland and Iceland. These species are the following: —

Bangia fuscopurpurea.	Ectocarpus Stilophoræ.
Porphyra umbilicalis.	E. tomentosoides.
Chantransia secundata.	E. penicillatus.
C. virgatula.	Sphacelaria radicans.
Polysiphonia urceolata.	Litosiphon filiformis.
Antithamnion floccosum.	Phyllitis zosterifolia.
Ceramium rubrum.	Dictyosiphon Chordaria.
Ralfsia ovata.	D. corymbosus.
R. verrucosa.	D. hippuroides.
Microsyphar Polysiphoniæ.	Castagnea virescens.

It seems most probable that these 20 species are to be met with in East Greenland.

The 11 species present in E. Iceland and absent from West Greenland are included in the above-mentioned figure. They are: —

Gigartina mamillosa.	Laminaria saccharina (in E. Greenl.)
Delesseria sanguinea.	L. færøensis.
Odonthalia dentata.	L. hyperborea.
Dumontia filiformis.	Alaria esculenta (in E. Greenl.)
Lithothamnion flavescens.	Fucus spiralis.
L. Ungerii.	

The 23 species present in E. Iceland and absent from East Greenland have also been already recorded. With the addition of the 9 of the above-mentioned species they are the following: —

<i>Bangia fuscopurpurea.</i>	<i>Ectocarpus tomentosoides.</i>
<i>Porphyra umbilicalis.</i>	<i>E. penicillatus.</i>
<i>Chantransia secundata.</i>	<i>Sphacelaria radicans.</i>
<i>Polysiphonia urceolata.</i>	<i>Litosiphon filiformis.</i>
<i>Antithamnion floccosum.</i>	<i>Phyllitis zosterifolia.</i>
<i>Ralfsia verrucosa.</i>	<i>Dictyosiphon Chordaria.</i>
<i>Ectocarpus Stilophoræ.</i>	<i>Castagnea virescens.</i>

These species might possibly also be found in East Greenland, as they are already known from West Greenland (see above), and in that case there could be only 9 E. Iceland-species which were not known from East Greenland.

In West Greenland there are 27 species which are not found in Iceland. These are: —

Ø <i>Harveyella mirabilis.</i>	Ø <i>Sphacelaria racemosa.</i>
<i>Callymenia sangvinea.</i>	<i>Phæosaccion Collinsii.</i>
<i>Delesseria Montagnei.</i>	Ø <i>Symphycarpus strangulans.</i>
<i>Polysiphonia elongata.</i>	<i>Kjellmania subcontinua.</i>
<i>Ceramium Areschoughii.</i>	<i>Coelocladia arctica.</i>
<i>C. septentrionale.</i>	Ø <i>Delamarea attenuata.</i>
Ø <i>Rhododermis elegans.</i>	<i>Dictyosiphon hispidus.</i>
<i>Lithothamnion intermedium.</i>	<i>Myriocladia callitricha.</i>
<i>Chantransia collopoda.</i>	Ø <i>Laminaria solidungula.</i>
Ø <i>Sorapion Kjellmani.</i>	Ø <i>L. longicuris.</i>
<i>Ectocarpus Pringsheimii.</i>	<i>L. cuneifolia.</i>
Ø <i>E. ovatus.</i>	Ø <i>L. groenlandica.</i>
Ø <i>E. pycnocarpus.</i>	Ø <i>Agarum Turneri.</i>
Ø <i>E. maritimus.</i>	

Of these species 13 (with Ø prefixed) are found in East Greenland.

In East Greenland 21 species are found which are not known from Iceland. In addition to the 13 above-mentioned species, they are the following: —

<i>Chantransia efflorescens.</i>	<i>Ectocarpus helophorus.</i>
<i>Dilsea integra.</i>	<i>Haplospora globosa.</i>
<i>Petrocelis polygyna.</i>	<i>Punctaria glacialis.</i>
<i>Cruoriopsis hyperborea.</i>	<i>Myrionema foecundum.</i>

The greater number of the West Greenland and East Greenland species here mentioned will probably be met with in Iceland, especially on the north and east coasts. It is less likely, however, that the following species will be found in Iceland: — *Callymenia sanguinea*, *Delesseria Montagnei*, *Dilsea integra*, *Petrocelis polygyna*, *Laminaria solidungula*, *L. cuneifolia*, *L. groenlandica* and *Agarum Turneri*.

According to the above comparisons Iceland most nearly resembles Finmark, and next to that place the Færøes; the resemblance to West

Greenland is rather less, and to East Greenland is least of all, as the following figures show: —

	common	not common
Iceland—Finmark	58 0/0	42 0/0
Iceland—the Færøes	55 0/0	45 0/0
Iceland—West Greenland	48 0/0	52 0/0
Iceland—East Greenland	39 0/0	61 0/0

S. Iceland is too little known to be compared with other districts, as has already been emphasized above. The resemblance to the Færøes will certainly prove to be much greater than is shown by the figures now known.

	common	not common
S. Iceland—the Færøes	44 0/0	56 0/0
S. and SW. Iceland—the Færøes	55 0/0	45 0/0

S. Iceland and SW. Iceland together resemble the Færøes to the same degree as do the coasts of Iceland taken as a whole. The fact that S. Iceland least resembles the Færøes is merely due to a deficient knowledge of its coasts.

As regards SW. Iceland—Finmark the percentage of species common to both places is 56 and that of not common 44. Thus, the resemblance is somewhat less than that between Iceland and Finmark.

If we now turn to E. Iceland we obtain the following figures: —

	common	not common
E. Iceland—West Greenland	58 0/0	42 0/0
E. Iceland—East Greenland	53 0/0	47 0/0
E. Iceland—White Sea	39 0/0	61 0/0

E. Iceland has thus the greatest floristic resemblance to West Greenland, resembles East Greenland somewhat less and the White Sea least of all, although the floral districts of E. Iceland and the White Sea resemble each other most closely when the species are grouped according to geographical distribution (see above).

V. THE VERTICAL DISTRIBUTION OF THE SPECIES.

IF we walk along the beach at low-tide we see a belt laid bare, the breadth of which varies according to the degrees of declivity of the coast and according to the tides — that is according to whether it is spring-tide or neap-tide. At spring-tide the belt is broad and at neap-tide narrow. The low-water mark of neap-tide divides the belt laid bare into two parts, an upper part which is laid bare during every low-tide and a lower part which is laid bare only at and about spring-tide. The upper part, between the upper limit of growth of the algal vegetation and the low-water mark of neap-tide, which almost coincides with the lower edge of the *Fucaceæ*-belt, I call the Upper Littoral Zone. The lower part, from the lower edge of the *Fucaceæ*-belt to the usual¹ low-water mark of spring-tide, I call the Lower Littoral Zone. Below low-water mark of spring-tide begins the vegetation which is constantly submerged. That the vegetation of the lower littoral zone is closely connected with that in the upper part of the constantly-submerged zone is natural and will be discussed subsequently.

In the following table a dash (—) denotes a habitat (depth) in which the species has been found many times, and a dot (·) one in which it has been found either once or comparatively rarely.

Table 7. The Vertical Distribution of the Species.

	Littoral zone		Depth (metre)											
	upper	lower	1—5	6—10	11—15	16—20	21—25	26—30	31—35	36—40	41—45	46—50	51—55	56—60
Rhodophyceæ.														
1 <i>Bangia fuscopurpurea</i>	—													
sl <i>Porphyra miniata</i>		—	—	—										

¹ No notice is taken of the extraordinarily low ebb-tides which occasionally occur and by which large *Laminariæ* are often exposed.

Table 7. The Vertical Distribution of the Species (continued).

	Littoral zone		Depth (metre)															
	upper	lower	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	88	
l <i>Porphyra umbilicalis</i>																		
s <i>Porphyropsis coccinea</i>																		
s <i>Conchocelis rosea</i>																		
sl <i>Chantransia microscopica</i>																		
s <i>C. Alariæ</i>																		
sl <i>C. secundata</i>																		
sl <i>C. virgatula</i>																		
sl <i>Chondrus crispus</i>																		
sl <i>Gigartina mamillosa</i>																		
sl <i>Ahnfeltia plicata</i>																		
s <i>Phyllophora Brodiaei</i> v. <i>interrupta</i>																		
sl <i>P. membranifolia</i>																		
s <i>Actinococcus subcutaneus</i>																		
s <i>Ceratocolax Hartzii</i>																		
sl <i>Cystoclonium purpurascens</i>																		
s <i>Turnerella Pennyi</i>																		
s <i>Euthora cristata</i>																		
s <i>Rhodophyllis dichotoma</i>																		
sl <i>Rhodymenia palmata</i>																		
s <i>Lomentaria clavellosa</i>																		
s <i>L. rosea</i>																		
s <i>Plocamium coccineum</i>																		
sl <i>Halosaccion ramentaceum</i>																		
s <i>Delesseria alata</i>																		
<i>D. Baerii</i> * <i>corymbosa</i>																		
s <i>D. sinuosa</i>																		
s <i>D. sanguinea</i>																		
<i>Bonnemaisonia asparagoides</i>																		
s <i>Polysiphonia urceolata</i>																		
l <i>P. fastigiata</i>																		
s <i>P. arctica</i>																		
sl <i>P. nigrescens</i>																		
s <i>Pterosiphonia parasitica</i>																		
sl <i>Rhodomela lycopodioides</i>																		
s <i>Odonthalia dentata</i>																		
sl <i>Callithamnion Arbuscula</i>																		
sl <i>C. scopulorum</i>																		
sl <i>Plumaria elegans</i>																		
s <i>Ptilota plumosa</i>																		
s <i>P. pectinata</i>																		
s <i>Antithamnion Plumula</i> v. <i>boreale</i>																		
sl <i>A. floccosum</i>																		
sl <i>Ceramium Deslongchampsii</i>																		

Table 7. The Vertical Distribution of the Species (continued).

	Littoral zone		Depth (metre)															
	upper	lower	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	88	
sl Myrionema Laminariæ.....	.	.																
sl Ascocyclus islandicus.....	.	.																
sl Microsyphar Polysiphoniæ.....	.	.																
s Streblonema æcidioides.....	.	.																
sl S. Stilophoræ v. cæspitosa.....	.	.																
l Pylaiella litoralis.....	.	.																
s Ectocarpus tomentosoides.....	.	.																
l E. tomentosus.....	.	.																
sl E. confervoides.....	.	.																
sl E. siliculosus.....	.	.																
sl E. penicillatus.....	.	.																
sl E. fasciculatus.....	.	.																
s E. Hinksiae.....	.	.																
sl Leptonema fasciculatum v. subcylindrica.....	.	.																
l Elachista fucicola.....	.	.																
l Sphacelaria britannica.....	.	.																
sl S. radicans.....	.	.																
s S. olivacea.....	.	.																
s Chaetopteris plumosa.....	.	.																
s Omphalophyllum ulvaceum.....	.	.																
sl Punctaria plantaginea.....	.	.																
sl Litosiphon filiformis.....	.	.																
l Isthmoplea sphaerophora.....	.	.																
sl Stictyosiphon tortilis.....	.	.																
sl Phæostroma pustulosum.....	.	.																
sl Scytosiphon Lomentaria.....	.	.																
sl Phyllitis zosterifolia.....	.	.																
sl P. fascia.....	.	.																
sl Coilodesme bulligera.....	.	.																
sl Dictyosiphon Ekmani.....	.	.																
sl D. Mesogloia.....	.	.																
sl D. Chordaria.....	.	.																
sl D. corymbosus.....	.	.																
sl D. hippuroides.....	.	.																
sl D. fœniculaceus.....	.	.																
s Desmarestia viridis.....	.	.																
s D. aculeata.....	.	.																
s D. ligulata.....	.	.																
sl Castagnea virescens.....	.	.																
sl Leathesia difformis.....	.	.																
sl Chordaria flagelliformis.....	.	.																
s Chorda tomentosa.....	.	.																

Table 7. The Vertical Distribution of the Species (continued).

	Littoral zone		Depth (metre)															
	upper	lower	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70		
s <i>Chorda Filum</i>																		
s <i>Saccorrhiza dermatodea</i>																		
s <i>Laminaria saccharina</i>																		
s <i>L. færoënsis</i>																		
s <i>L. nigripes</i>																		
s <i>L. digitata</i>																		
s <i>L. hyperborea</i>																		
s <i>Alaria Pylaii</i>																		
s <i>A. esculenta</i>																		
l <i>Fucus spiralis</i>																		
l <i>F. inflatus</i>																		
l <i>F. serratus</i>																		
l <i>F. vesiculosus</i>																		
l <i>Pelvetia canaliculata</i>																		
l <i>Ascophyllum nodosum</i>																		
Chlorophyceæ.																		
l <i>Chlorochytrium Cohnii</i>																		
s <i>C. inclusum</i>																		
sl <i>C. dermatocolax</i>																		
l <i>C. Schmitzii</i>																		
sl <i>Codiolum Petrocelidis</i>																		
l <i>C. gregarium</i>																		
l <i>C. pusillum</i>																		
l <i>Percursaria percursa</i>																		
l <i>Enteromorpha aureola</i>																		
l <i>E. Linza</i>																		
l <i>E. intestinalis</i>																		
l <i>E. clathrata</i>																		
l <i>Monostroma groenlandicum</i>																		
sl <i>M. Grevillei</i>																		
sl <i>M. undulatum</i>																		
sl <i>M. fuscum</i>																		
sl <i>Ulva lactuca</i>																		
l <i>Prasiola polyrrhiza</i>																		
l <i>P. furfuracea</i>																		
l <i>P. stipitata</i>																		
l <i>Ulothrix consociata</i> v. <i>islandica</i> ...																		
l <i>U. subflaccida</i>																		
l <i>U. pseudoflacca</i>																		
l <i>U. flacca</i>																		
l <i>Pseudendoclonium submarinum</i> ...																		
sl <i>Entoderma Wittrockii</i>																		

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Table 7. The Vertical Distribution of the Species (continued).

	Littoral zone		Depth (metre)															
	upper	lower	1—5	6—10	11—15	16—20	21—25	26—30	31—35	36—40	41—45	46—50	51—55	56—60	61—65	66—70	88	
1 <i>Acrochaete parasitica</i>																		
sl <i>A. repens</i>		?	?															
sl <i>Bolbocoleon piliferum</i>																		
1 <i>Ulvea fucicola</i>																		
sl <i>Pringsheimia scutata</i>																		
1 <i>Ochlochaete ferox</i>																		
1 <i>Urospora mirabilis</i>																		
1 <i>U. Hartzii</i>																		
sl <i>U. Wormskioldii</i>																		
1 <i>Chaetomorpha tortuosum</i>																		
sl <i>C. Melagonium</i>																		
1 <i>Rhizoclonium riparium</i>																		
sl <i>Spongomorpha vernalis</i>																		
1 <i>Acrosiphonia albescens</i>																		
sl <i>A. incurva</i>																		
sl <i>A. hystrix</i>																		
1 <i>A. flabelliformis</i>																		
1 <i>A. penicilliformis</i>																		
1 <i>Cladophora rupestris</i>																		
1 <i>C. hirta</i>																		
1 <i>C. sericea</i>																		
1 <i>C. glaucescens</i>																		
1 <i>C. gracilis</i>																		
s <i>Gomontia polyrrhiza</i>																		
s <i>Ostreobium Queketti</i>																		
Cyanophyceæ.																		
1 <i>Pleurocapsa amethystea</i>																		
1 <i>Plectonema norvegicum</i>																		
1 <i>Phormidium autumnale</i>																		
1 <i>Spirulina subsalsa</i>																		
1 <i>Calothrix scopulorum</i>																		
1 <i>Rivularia atra</i>																		
Fungi.																		
<i>Dothidella Laminariæ</i>																		

A. Upper Littoral Zone.

The preceding table shows that 18 species of *Rhodophyceæ*, 18 species of *Phæophyceæ*, 36 species of *Chlorophyceæ* and 6 species of *Cyanophyceæ* grow in the upper littoral zone; that is, 78 species

in all. Of these species some are common and others rare; some are found exclusively in the upper littoral zone and others extend further downwards. In order to show this more distinctly, each group will here be dealt with separately and in detail.

Rhodophyceæ. Of the 18 species mentioned 5 are common, and the remaining 13 rarer. The following are the commonly distributed species: *Bangia fuscopurpurea*, which is found exclusively in the upper littoral zone; *Porphyra umbilicalis* which is found also in the lower littoral zone; *Polysiphonia fastigiata* which occurs exclusively on *Ascophyllum nodosum* in the upper littoral zone; *Rhodochorton Rothii* which extends to a depth of 10 metres, and *Hildenbrandia rosea* which extends to a depth of 5 metres. The three first-named species are common in places exposed to the light in the littoral zone: *Rhodochorton* and *Hildenbrandia*, on the other hand, occur most frequently as an undergrowth, or in shady clefts (*Rhodochorton*), and at the bottom of pools (*Hildenbrandia*). These two species are met with more rarely in places exposed to the light. The 13 species which occur in the upper littoral zone, but which must be called somewhat rare, are there shade-loving, and are then found either as an undergrowth or in shady clefts and depressions. Some are epiphytes, and are then protected against desiccation by the host-plant. The greater number of these 13 species are common in the lower littoral zone, and the 3 *Ceramium*-species which are recorded exclusively from the upper littoral zone may doubtless be expected to occur also in the lower littoral zone. *Conchocelis* does not occur in the lower littoral zone but is found at a depth of 6—35 metres.

Phæophyceæ. Of brown algæ the *Fucaceæ* play the most important rôle. The species are few in number, but are of social growth, and occur in such quantities that they comprise by far the greater portion of the bulk of the plants in the upper littoral zone. Of the 18 species mentioned above, 12 are commonly distributed, and 6 are more rare, in the upper littoral zone. Of the 12 common species, 9 are found exclusively in the upper littoral zone, viz., 6 species of *Fucaceæ*, *Sphacelaria britannica*, *Ectocarpus tomentosus* and *Ralfsia clavata*; *Pylaiella littoralis*, *Elachista fucicola* and *Isthmoplea*, on the other hand, range to a depth of about 10 metres. Of the rarer species, *Petroderma* is found exclusively in the upper littoral zone, *Ralfsia verrucosa* is most frequent in the upper littoral zone, but is also met with in the lower littoral zone, as an epi-

phyte; the remaining 4 species are common in the lower littoral zone, and occur in pools in the upper littoral zone, consequently they cannot, strictly speaking, be reckoned as belonging to the upper littoral zone.

Chlorophyceæ. In the table, 36 species of green algæ are mentioned from the upper littoral zone. Of these, 15 are characterized as common and 21 as rarer. 31 species are recorded exclusively from the upper littoral zone; 2 species, *Entoderma* and *Bolbocoleon* are more frequent in the lower littoral zone; one species *Chlorochytrium dermatocolax* is as frequent in the lower littoral zone as in the upper littoral zone, one species *Ulothrix flacca*, which must be considered a decidedly littoral species, grows to a depth of about 10 metres. *Ulvella fucicola* also grows to a depth of 5 metres, but must nevertheless be considered littoral. In addition to these 36 species, others may be found in the upper littoral zone, which have a more downward extension (e. g. *Monostroma Grevillei* var. *arctica*, *M. fuscum*, *Acrosiphonia incurva*, and others), but they generally keep to the pools.

Cyanophyceæ. All the species hitherto found (6) grow in the upper littoral zone.

The species which are recorded from the upper littoral zone may be put into two divisions. The one comprises the species which are common in the upper littoral zone and are adapted to growth in places exposed to the light and the wind during the period of exposure; these species, then, might be termed strictly littoral. The other division comprises species which are common in the lower littoral zone or extend even further downwards. The greater number of these species does not occur in the open littoral zone, but is found as an undergrowth or in shady clefts, or in pools. The real home of these species is lower down than in the upper littoral zone, and for this reason they can scarcely be designated littoral species.

According to the above, there are in all 58 strictly littoral species: *Rhodophyceæ* 5 species, *Phæophyceæ* 14 species, *Chlorophyceæ* 33 species and *Cyanophyceæ* 6 species.

The upper littoral zone is thus essentially characterized by a paucity of species of red algæ, by many species of green algæ and by a preponderance of *Fucaceæ*. The number of the species of brown algæ is of less importance; it is three times as large as that of the red algæ and about half as large as that of the green algæ.

If we reckon, in percentages, the number of species of each group of the total number of species in the upper littoral zone we obtain the following figures. The strictly littoral species (58 in all) are indicated by *a*, the other species (20 in all) not strictly littoral are indicated by *b*, but no attention is paid to those species which may be found in the upper littoral zone and appear to grow by preference in pools.

	Rhodophyceæ	Phæophyceæ	Chlorophyceæ	Cyanophyceæ
<i>a</i>	5 (9 0/0)	14 (24 0/0)	33 (57 0/0)	6 (10 0/0)
<i>a</i> + <i>b</i>	18 (23 0/0)	18 (23 0/0)	36 (46 0/0)	6 (8 0/0)

So far as the abundance of species is concerned I lay special stress on the red algæ, green algæ and blue-green algæ. It would be confusing, especially as regards the red algæ, to reckon the *b*-species as strictly littoral, nor can this be done, because they are not adapted for life in the open littoral zone. As regards the brown and green algæ, on the other hand, it is of no essential importance whether the *b*-species are included or not, as they are so few in number.

If we calculate how great a proportion the strictly littoral species form of the combined number of each group we obtain the following figures: —

	Rhodophyceæ	Phæophyceæ	Chlorophyceæ	Cyanophyceæ
Species known at present from Iceland..	76	67	51	6
Strictly littoral species	5 (6.6 0/0)	14 (20.9 0/0)	33 (64.7 0/0)	6 (100 0/0)
<i>a</i> + <i>b</i> (see above)....	18 (23.7 0/0)	18 (26.8 0/0)	36 (70.6 0/0)	6 (100 0/0)

B. The Lower Littoral Zone and the Belt below down to a depth of about 10 metres.

1. The Lower Littoral Zone. From this are recorded 93 species in all (Table 7), viz. 39 *Rhodophyceæ*, 37 *Phæophyceæ* and 17 *Chlorophyceæ*. Of these 93 species, the upper and lower littoral zones have 15 species in common (8 red, 5 brown, 2 green) which do not extend further downwards; the greater number of these belong, strictly speaking, to the lower littoral zone, as, in the upper littoral zone, they usually occur in pools or very shady spots. 19 species (8 red, 11 brown) have been found only in the lower littoral zone; but the majority of them probably occur also below the limit of low-tide, and, in any case, some have their area of distribution

close to this limit; 6 species (1 red, 3 brown, 2 green) have their area of distribution in the upper and lower littoral zones, and to a depth of 10 metres, these species are mentioned under the Upper Littoral Zone, and there, 5 of them are reckoned as littoral. 35 species (10 red, 15 brown, 10 green) grow in the lower littoral zone, and to a depth of about 10 metres. They appear to be about as common in the lower littoral zone as in the belt between the limit of low-tide and the depth mentioned. 18 species (12 red, 3 brown, 3 green) grow in the lower littoral zone, and to a depth of more than 10 metres; these belong to the species which have a lower downward range, 15 of them have their uppermost limit in the lower littoral zone, and 3 of them in the upper littoral zone.

The species characteristic of the lower littoral zone are especially the 19 species which are found there only, and the 35 species which extend to a depth of about 10 metres, for some of these (e. g. *Rhodymenia* and *Halosaccion*), by occurring in masses, often characterize large portions of the lower littoral zone.

2. The Belt down to a depth of about 10 metres. In the table 103 species are recorded from this belt. Of these, two occur also in the upper littoral zone, and have been previously mentioned (*Rhodochorton Rothii* and *Hildenbrandia*), 6 occur also in the upper and lower littoral zones and are mentioned above, 35 occur also in the lower littoral zone (see under this heading); while 9 species are found only at this depth, but of these some may be presumed to extend further downwards and some may possibly occur in the lower littoral zone. 19 species extend downwards, with their uppermost limit in the upper and lower littoral zones, as, for example, *Conchocelis rosea* which occurs in the upper littoral zone and is absent from the lower littoral zone, besides the 18 species mentioned under the Lower Littoral Zone. 32 species with a downward range have their uppermost limit at a depth of about 10 metres.

Besides the 9 species which are found only in this belt, it is especially the 35 species which this belt has in common with the lower littoral zone which characterize the belt, as some of them — those mentioned under the Lower Littoral Zone — by occurring in masses often characterize large portions of the bottom.

By comparison it can easily be seen that the lower littoral zone is much more closely related to this belt than to the upper littoral zone, which, amongst other things, is evident from the great

number of red algæ in the lower littoral zone. This can be distinctly seen from the following figures: —

Upper Littoral Zone		Lower Littoral Zone
58 species (<i>a</i>)		93 species
not common	common	not common
51 (35.42 %)	7 (4.86 %)	86 (59.72 %)
Upper Littoral Zone		Lower Littoral Zone
78 species (<i>a</i> + <i>b</i>)		93 species
not common	common	not common
54 (36.73 %)	24 (16.33 %)	69 (46.94 %)
Lower Littoral Zone		From the limit of low-tide to a depth of about 10 m. 103 species.
93 species		
not common	common	not common
34 (24.82 %)	59 (43.06 %)	44 (32.12 %)

The figures show that the upper littoral zone is very unlike the lower littoral zone, especially if only the species which are characteristic of the latter, or which occur in the open littoral zone (*a*), are taken into consideration, which is most correct, as the shade-loving species in the upper littoral zone must be regarded as stragglers from associations lower down. As previously mentioned, the lower littoral zone bears the greatest resemblance to the belt which exists lower down (to a depth of about 10 metres).

The species which have their lower limit of growth at a depth of about 10 metres and which are commonly distributed in the lower littoral zone I designate semi-littoral because they are found both laid bare during low-tide in the lower littoral zone and constantly submerged in the belt below; as these species especially characterize the lower littoral zone and the belt below to a depth of about 10 metres I designate this area the semi-littoral zone. It must not be concluded, however, that semi-littoral vegetation covers the bottom everywhere down to a depth of 10 metres; below the limit of low-tide the semi-littoral vegetation appears rather to consist of stragglers from the lower littoral zone into the *Laminaria*-belt. Thus the semi-littoral zone is situated between the *Fucus*-belt and the *Laminaria*-belt. The species which specially occur in the semi-littoral zone I designate on the whole as semi-littoral, also those which are found in the lower littoral zone and are not found below the limit of low-tide; they will probably be found also below this limit. Species which are common in the lower littoral zone and are rare in the

upper littoral zone, but not known below the limit of low-tide I have also designated semi-littoral as they might be expected to grow lower down.¹

C. The Sublittoral Species.

These species play the principal rôle in the sublittoral vegetation. This may be characterized in a somewhat similar manner as the vegetation of the upper littoral zone, although conversely as regards red and green algæ, viz. by a large number of red algæ and an extremely small number of green algæ and by the occurrence of a mass of *Laminariaceæ*. In Table 7, these species are marked with an s before the name. Their number is shown by the following figures: —

	Species		
	Littoral	Semi-littoral	Sublittoral
Red ²	5	30	39
Brown	14	31	22
Green	33	15	3
Blue-green	6		
Total...	58	76	64

From a comparison of the number of species of the sublittoral zone with that of the littoral and semi-littoral zones it is seen that it is smallest in the littoral zone, somewhat larger in the sublittoral zone and considerably larger in the semi-littoral zone. Species of green algæ occur most abundantly in the littoral zone, and their number is infinitesimal in the sublittoral zone. Red algæ are most numerous in the sublittoral zone and very scarce in the littoral zone. The brown algæ are more evenly distributed in the different zones, yet they are richest in species in the semi-littoral zone. The blue-green algæ are found exclusively in the littoral zone.

In the semi-littoral zone the large brown algæ do not occur in masses like, for example, the belt of *Fucus* in the upper littoral

¹ As regards the majority of the species (see Table 7) it is easy to decide whether they are littoral, semi-littoral or sublittoral, but there are some species, nevertheless, which it is difficult to refer definitely to any one of the three zones mentioned, and therefore it is sometimes a matter of opinion whether they should be reckoned in the one or the other. By perusing the table these species are easily detected.

² Two species, *Delesseria Baerii* and *Bonnemaisonia asparagoides* are not included as their habitat is unknown to me (see 31, pp. 140, 141).

zone and the belt of *Laminaria* in the sublittoral zone. This is possibly the reason why the semi-littoral zone is richest in species.

In Table 7, 64 species are recorded as sublittoral. Besides these, semi-littoral species occur in this zone, especially as epiphytes, or, more rarely, as undergrowth. 12 species, almost all semi-littoral, which extend to a greater depth than 10 metres are mentioned in the table. In addition, about 14 species can be regarded as epiphytic, particularly in the upper part of the sublittoral zone. The sublittoral vegetation is thus composed of 64 sublittoral species and of about 26 semi-littoral species, or about 90 species in all.

Lower Limits of Growth.

As far as the lower limit of growth is concerned the species which are found below low-tide must be dealt with collectively. In the following table, which shows the lower limits of growth, all the depths at which species have been known to occur have been, as a rule, taken into consideration, and thus the table does not indicate the depth of their general distribution or the depth at which they form associations (see under Vegetation). In the table, 2 red algæ are omitted, as I have no further knowledge regarding their habitats (31, pp. 140, 141). These species are *Delesseria Baerii* and *Bonnemaisonia asparagoides*. As regards the green algæ it must also be stated that I have not taken into consideration the records from greater depths than 10 metres. I myself am responsible for some of these records; the algæ often were detached, but sometimes it appeared as if they really had been growing at the depth recorded. I always, however, have entertained some doubt concerning this, and consequently prefer at present not to consider records from such depths. Regarding *Chlorochytrium inclusum* the record is correct, as it grew in *Turnerella*, which was attached to the bottom at a depth of 30 metres. For *Gomontia* and *Ostreobium* I have given the most common depth, down to about 40 metres, but I have also obtained these species, growing inside an old shell of *Mya*, from a depth of about 60 metres.

It should be further stated that I do not know the depth to be given for *Desmarestia ligulata*. This species has been found by Ove Paulsen between the Vestmannaeyjar and South-Iceland; I presume that it grew at a depth of about 20 metres.

Lower Limits of Growth in metres (see Table 7).

	About 5—10	About 15—20	About 25—30	About 35—45	About 60 and more
Red algæ	13	10	10	15	7
Brown algæ	19	8	4	5	3
Green algæ	16	..	1	2	..
Total	48	18	15	22	10
			37		

In the above table 113 species are mentioned, of which 48 do not extend to a greater depth than about 10 metres, 18 extend to about 20 metres, 15 to about 30 metres, 22 to about 40 metres and 10 to about 60 metres and more. Thus there appears to be a floristic boundary at a depth of about 10 metres; while another boundary can be faintly distinguished at a depth of from about 30 to 40 metres, as there are 37 species which appear not to extend further downwards; and here, also, is situated the lower limit of growth of most of the *Laminariaceæ* which play the same rôle on the sublittoral bottom as the *Fucaceæ* play in the littoral zone. Exactly where the lower limit of growth, as regards the marine algæ in Iceland, is situated — whether it lies at a depth of about 60 to 80 metres or deeper — I cannot at present decide, but it is most probable that the vegetation at greater depths than 60 metres is, in any case, extremely poor in species.

According to the above statements the lower limits of the algæ are as follows: —

The littoral limit (Upper Littoral Zone)	53 species	26.77 %
The limit of low-tide	32 —	16.17 %
At about 10 metres	48 —	24.24 %
At about 20 metres	18 —	9.09 %
At about 30—about 40 metres	37 —	18.68 %
At about 60 metres and more	10 —	5.05 %

— 198 species.

By future investigations all these figures will undoubtedly be altered and many of them to no inconsiderable extent; but the four principal boundaries, namely the littoral limit, the 10-metre limit, the 30—40 metre limit and the absolute depth-limit will always remain evident.

As regards the absolute depth-limit I cannot make any definite statement. The dredgings which I myself have undertaken have all been conducted with a small dredge from a small rowing boat.

The positive results which are obtained with this small dredge are satisfactory enough when the material is inspected with sufficient criticism, but it should not be concluded with certainty from a negative result (that is, when absolutely nothing comes up from the bottom) that no plants grow there. In great depths, also, dredging is difficult from a small rowing-boat. In some places only, in SW. Iceland and E. Iceland, have I undertaken dredgings in a depth of about 80 metres, and the result has been negative. In those places where the plummet revealed a clayey bottom, it was certain that no plants were growing there. Off S. and SW. Iceland I have met with no vegetation at a greater depth than about 40 metres, but in Reyðarfjörður in E. Iceland, on the other hand, I have come across plants at as great a depth as about 60 metres. This might indicate that the vegetation extends further downwards in E. Iceland; but as the observations are too few, this point must remain undecided until further investigations are forthcoming.

It was a fairly common occurrence, especially in the fjords of E. Iceland, to encounter sunken fragments of algæ (often strictly littoral species) and of mosses in depths of more than 22 metres. In Seyðisfjörður I came across leaves of *Betula* and *Salix* at a depth of 14—20 metres.

C. H. Ostenfeld (the Ingolf Expedition) found *Lithothamnion laeve* in great quantities at a depth of 88 metres off the north coast of Iceland, and R. Hörring (on board the "Diana," off E. Iceland) found *Lithothamnion tophiforme* at a depth of 70 metres. In depths of from 60 to about 100 metres Hörring found, in addition, fragments of various algæ, amongst which were strictly littoral species, and of mosses which had evidently fallen to the bottom. In order to draw the attention of future investigators to this matter it must further be mentioned that Hörring brought home in spirits a young plant of *Laminaria saccharina* from a depth of from 81 to 104 metres (Mjóifjörður, 14.5.1898, St. XIII) and on the label was written "In the trawl were many large *Laminariæ* which had been torn away from the bottom." The *Laminaria* brought home appeared normal, and, if it had fallen to the bottom could only have lain there for a short time. What is most likely is that the trawl passed over an uneven bottom, and that the *Laminariæ* grew at a lesser depth than that mentioned; or is it possible that the deep-water form of *Laminaria saccharina* ranges so far downwards? I leave it to future investigation to decide this question.

VI. MARINE ALGAL VEGETATION AND SEA-GRASS VEGETATION.

THE vegetation of the sea is naturally divided into two principal groups: the Plankton composed of the small plants floating passively in the water, and the Benthos which comprises the species attached to a substratum. In this article only the latter is dealt with.

The Benthos¹ falls naturally into two divisions, viz. the lithophilous vegetation, the communities of marine algæ (subformation of marine algæ, Halo-nereid communities, Warming, 72, p. 170), and the vegetation of loose soil (Enhalid-formation, Warming, 72, p. 177).

The Benthos has been divided in different ways. J. G. Agardh in 1836 (*Novitiæ Floræ Sveciæ*) divided the marine vegetation into three zones, a green zone above, a brown zone in the middle and a red zone lowest of all. Lyngbye in the same year, also divided the vegetation into three zones (*Rariora Codana*, printed 1879—80), a zone of green algæ (*Ulvaceæ*) being above, a zone of red algæ in the middle and a zone of *Laminariæ* below this. Ørsted (77), like Agardh, also divided the vegetation in the Øresund into three zones, but Ørsted has the merit of being the first to explain that the division of the zones depends upon the depth to which the light penetrates, and upon the colour of the light at the various depths.

Kjellman has divided the algal Benthos into regions. Where there is a tide, the littoral region is reckoned as being between the highest high-water mark and the lowest ebb-tide mark; where, on the other hand, there is no tide Kjellman reckons the littoral region as extending from the uppermost limit of the algal vegetation to a depth of $1\frac{1}{2}$ —2 fathoms (34, p. 7). The sublittoral region extends from the lower limit of low-tide, or else from a depth of $1\frac{1}{2}$

¹ No notice is taken of the bacterial flora of the sea.

—2 fathoms, down to a depth of 20 fathoms; and finally the elittoral region stretches from the 20-fathom contour downwards. This division, unchanged in its main features, is generally employed. The boundary between the littoral and sublittoral regions is, I think, commonly supposed to be rather sharply defined in places with tides, and less sharply defined where tides do not occur.

By this division into three regions the algal Benthos is divided into three belts of different depth. Although the boundary lines thus drawn may be described as floristic boundaries, as regards many species, yet they cannot always be regarded as natural limits of vegetation. If natural limits of vegetation are to be drawn, several factors must be taken into consideration. From depth-records, pure and simple, a somewhat clear idea may naturally be formed of the conditions of light, but not of the salinity and warmth. If the conditions of light, salinity and warmth in those layers of water where the algal vegetation lives were known all the year round it would be easy to characterize the limits of the vegetation. The great importance of the salinity to algal vegetation is well-known and is emphasized by Rosenvinge (63), Svedelius (71), Børge-sen (12) and Kylin (45), amongst others.

The ecological factors in the coastal waters round Iceland are not so well known that I am able to draw the natural limits of the vegetation by means of them. My starting point is, therefore, the vegetation itself, and from the appearance of the vegetation it is possible, to a certain extent, to form an opinion as regards the ecological factors, in the same way as an opinion may be formed from these concerning the appearance and composition of the vegetation.

The marine algal vegetation divides itself into several zones as the Benthos does in fresh water. The divisions between the zones in the sea are very distinct: some species seem to be spot-bound or very sensitive to changes of level; other species may occur in two or several zones; but it depends especially, I think, on the quality of the water, the intensity of the light and, where there are tides, on the period of exposure (in the littoral zone).

By studying the vertical distribution of the species and associations, I have come to the conclusion that the marine algal vegetation may be divided into three zones almost parallel one with another: the Littoral Zone, the Semi-littoral Zone and the Sublittoral Zone.

The Littoral Zone understood in a more restricted sense is identical with the upper littoral zone and extends almost to the

low-water mark of neap-tide, and is exposed during each low-tide; the upper littoral zone is, then, the littoral zone proper, which doubtless corresponds exactly with Kolderup Rosenvinge's limitation of the littoral zone in Greenland, but not entirely with Børgesen's limitation of the littoral zone in the Færøes, as some of the Færøese littoral associations seem to belong to the next belt.

The semi-littoral zone extends from about the low-water mark of neap-tide to a depth of about 10 metres, and thus extends over the lower littoral zone, and even lower than that. In reality this zone comprises the lower littoral zone including stragglers below the low-water mark of spring-tide to a depth of 10 metres. That part of the zone lying in the lower littoral zone is laid bare at and about spring-tide, but is submerged at neap-tide.

The sublittoral zone extends from the low-water mark of spring-tide to the absolute depth-limit.

There seems to me to be no reason for calling any part of the Benthos elittoral. Even if the 40-metre contour is a lower limit of growth in the case of several species, and is, approximately, the lower boundary of the *Laminaria*-community, yet the upper boundary of the red-algæ communities which extend further downwards than 40 metres lies much higher, and the 40-metre contour thus cuts straight through natural communities. It cannot, therefore, be considered the principal boundary as regards the whole of the constantly-submerged vegetation. Strömfelt (l. c.) is of the opinion that, possibly, elittoral vegetation does not exist on the coasts of Iceland. According to Kjellman the elittoral vegetation is extremely poor in species, and probably has a limited distribution everywhere in the northern seas. From what has been said above respecting the 40-metre line, and from a comparison with Greenland (Rosenvinge, 63) and the Færøes (Børgesen, 11 and 12), it is obvious that a division of the constantly-submerged vegetation at this depth-line is not quite natural in the northern seas. It is more correct, therefore, to do as Rosenvinge and Børgesen do, and to class the vegetation as sublittoral down to the absolute depth-limit.

In the following I do not employ the term "region," which is now generally used to describe somewhat limited subdivisions of

the vegetation, as I have thought it better to designate the algal Benthos taken as a whole by this word, and to call it the "algal region."

I have also avoided the term "formation." The algal formations established by Kjellman and others are not real formations, but only associations (Warming, 72, p. 171), and the entire marine algal vegetation is given as a subformation of marine algæ (Halonereid; Warming, 72, p. 169). I do not think that the term "formation" should be used in connection with the algal region in any other sense than that in which it is used in connection with land vegetation. As the term "facies" cannot be used in English to denote a vegetation-unit (Warming, 72, p. 146, foot-note) I have avoided it.

I divide the vegetation in each of the three zones into associations, and where I think they are closely allied I combine them into communities.

Sometimes by the suffix "etum" is meant the subordinate part of an association, and sometimes a vegetation-unit which almost corresponds with an association.

ACCOUNT OF THE MARINE ALGAL VEGETATION AND THE SEA-GRASS VEGETATION.

A. The Marine Algal Vegetation.

a. The Littoral Zone.

aa. The Photophilous or strictly Littoral Communities.

1. The *Prasiola stipitata*-association.
2. The Community of Filiform Algæ.
3. The Community of Fucaceæ.
+ The *Pelvetia-Fucus-spiralis*-belt.
++ The *Fucus*-belt.

4. The *Enteromorpha*-association.

5. The *Acrosiphonia*-association.

bb. The Shade-vegetation.

6. The *Hildenbrandia*-association.

7. The *Rhodochorton*-association.

cc. The Vegetation of Tide-pools.

b. The Semi-littoral Zone.

8. The *Monostroma*-association.

9. The *Chorda*-association.

10. The Community of Rhodymenia.
11. The Polysiphonia urceolata-association.
12. The Community of Corallina.
13. The Crustaceous Alga-association.
- c. The Sublittoral Zone.
 14. The Community of Laminariaceæ.
 15. The Desmarestia-association.
 16. The Deep-water Community of Florideæ.
 17. The Lithothamnion-association.
 18. The Community of Crustaceous Algæ.
- B. The Sea-grass Vegetation.
 1. The Zostera-association.

A. The Marine Algal Vegetation.

a. The Littoral Zone.

The Littoral Communities. The littoral vegetation is composed of several communities. These are left dry during low-tide, with the exception of the pool-vegetation; but the period during which the different communities are left dry varies greatly. I am not prepared to state accurately the period of exposure, but I presume that the lowest littoral communities will be laid bare for about 1—2 hours under normal conditions, while the uppermost communities will be submerged for about one hour, and will be laid bare for about 11 hours. On exposed coasts the period of exposure is shortened by the beat of the waves. The ecological factors differ not a little in the uppermost and lowermost part of the littoral zone, and because of this difference the vegetation is divided into longitudinal belts along the coasts. The littoral vegetation falls naturally into three divisions: the light-loving or strictly littoral communities, the shade-loving communities, and the pool-vegetation. In the following description of the vegetation, the communities in each of the three zones are arranged as far as possible according to depth, and in such a way, that the uppermost come first and the lowest come last. This rule, however, cannot always be adhered to.

aa. The Photophilous or strictly Littoral Communities.

These communities are found in places in the littoral zone which are directly exposed to light during low-tide. They are composed of blue-green, green, brown and red algæ; the

brown algæ are found most abundantly, the green algæ come next, red algæ occur less frequently, and blue-green algæ are found in the smallest quantity. The substratum is either rock — solid rock or else talus of debris — or pebbles, or in many places consists of gravel, clay or mud. The perennial species prefer almost exclusively the rock-substratum; but they occur, though very seldom, on other substrata, and are then, as a rule, dispersed here and there on small stones, viz. on a gravel-clay soil at the head of the fjords. The annual, short-lived species also occur most frequently on a rock-substratum, but they also occur fairly frequently on the pebbles of the littoral zone.

1. The *Prasiola stipitata*-association.

This association extends furthest upwards and is found well developed on the rocks in several places round the coasts. It is usually almost on a level with the *Verrucaria-maura* belt and, upwards, sometimes approaches the outposts of the land-vegetation. At the highest water-level it is covered by the sea for a short period, or is, at least, washed by the breaking waves; but such high water occurs only rarely, and in normal conditions this association must, without doubt, be content with the spray from the waves during spring and summer. On less exposed coasts this association is, as a rule, sharply defined from the community of filiform algæ which exists below, but on a very exposed coast the boundary is more variable.

The dominant species in this association is the small, leaf-like *Prasiola stipitata*, which grows very socially upon the tops of flat rocks. As it has its distribution almost exclusively in this belt it seems natural to designate the association by its name. It is essentially adapted to live in the air, and is capable of withstanding desiccation well, which may be perceived, *inter alia*, by the fact that it does not seek clefts and crevices but grows on surfaces which are exposed to light, wind and weather. The density of the vegetation must also afford each individual some protection against desiccation. In spring and summer long periods must occur during which this association is not wetted by the sea, and, during summer drought, I have often seen *Prasiola stipitata* as dry as a bone upon the rocks. *Prasiola furfuracea* also occurs side by side with this species, but is rarer.

Species and varieties of species, such as *Enteromorpha intesti-*

nalis f. *micrococca* and *Rhizoclonium riparium*, which essentially belong to the lower belts, but can accommodate themselves to life in the air, are also included as members of this association. They are species which, owing to their structure or their manner of growth, are capable of enduring desiccation. *Enteromorpha intestinalis* f. *micrococca* has, as is well known, small cells, the walls of which are very thick, the inner walls, in particular, being highly thickened, serving possibly as reservoirs for water. It prefers fissures in the rocks, where, as a rule, it is less exposed than the species characteristic of the association. Sometimes, however, I have come across f. *micrococca* growing, like *Prasiola stipitata*, on flat rocks manured by birds, but then it had a different aspect and, at first sight, somewhat resembled *Prasiola*. *Rhizoclonium* also occurs in fissures, where, owing to its manner of growth — that is to say its pulvinate form — it is protected from desiccation during the long periods of drought. *Calothrix scopulorum* also occurs as a member of the *Prasiola*-association and forms *Calothriceta* of limited dimensions; the individuals are procumbent and are placed so closely together that the rock is completely covered, and thus they protect each other from desiccation. From a biological point of view, the manner of growth of this species, in the dry condition, is similar to that of the crustaceous algæ. *Enteromorpha intestinalis* f. *minima* also occurs in this community.

The species in this community grow, as a rule, in small, pure societies which form a narrow, though not a continuous belt along the coast. This belt is situated higher on exposed coasts than it is on those which are less exposed.

The *Prasiola*-association is undoubtedly commonly distributed in neighbouring countries, but the constituting species may be different. In Greenland (Rosenvinge, 63, p. 200) *Calothrix scopulorum*, *Ectocarpus maritimus*, and *Rhizoclonium riparium* occur only in the uppermost part of the littoral zone. This vegetation, however, scarcely corresponds with the *Prasiola*-association, but rather with that occurring below. In the Færøes, however, an exactly corresponding association is found, which Børgesen calls the *Chlorophyceæ*-formation (12, p. 712). The Færøese *Chlorophyceæ*-formation, however, appears to be more luxuriant and is composed, in part, of other species. A *Prasiola*-association (Foslie, 18, p. 127) similar to that of Iceland is evidently found in Finmark.

2. The Community of Filiform Algæ.

It is not easy to find a suitable name for this community. It is composed of several species which are all equally common and are all dominant to almost the same degree. As almost all the species are filiform and non-branching, it seems to me that the community may fitly be named in accordance with the form of the frond.

The community of filiform algæ forms a narrow belt, which is often continuous along fairly considerable stretches of the coast, at about the average limit of high water. The vertical height of the belt is inconsiderable, about one foot, but the breadth conforms somewhat to the slope of the coast, and may attain to 3—4 feet, or even more. This vegetation is very well developed on the face of vertical rocks, and the various associations of the community can be distinctly seen, one above the other, as parallel bands of varying colour. The species which occur most frequently are the following: —

Ulothrix flacca.

Bangia fuscopurpurea.

Urospora mirabilis.

Porphyra umbilicalis f. *typica*.

Monostroma groenlandicum.

These are all dominant species, and form extensive associations, of which some are pure and others mixed. Other species may also occur, but only in lesser quantities.

The *Ulothrix*-association, as a rule, reaches highest up the cliff. The principal species is *Ulothrix flacca*, which forms a distinct belt, extending rather far in a horizontal direction. On rock-walls, the filaments are often comparatively long, and are moved to and fro over the entire belt by the beat of the waves or the ripple of the sea at flood-tide; during the period of exposure they hang down, pressed closely against the face of the rocks. The outer filaments protect the underlying ones from desiccation during low-tide, and thus it happens rather frequently that the outer layer is dry while the protected layer — that nearest to the rocks — is moist. In this way the social growth of the plants protects them against desiccation (cf. Rosenvinge, 63, p. 201), at any rate under normal conditions, and so long as no exceptionally long periods of drought occur. It happens rather frequently, however, that the *Ulothrix*-vegetation becomes quite dry during low-tide. This is especially the case when the vegetation occurs on boulders in the littoral zone where, when the water subsides, the filaments radiate

from the highest point of the stone. Such a stone-surface is smooth and dries more quickly and completely than the uneven face of the rock. This vegetation appears to maintain itself well in spite of being completely dried up, day after day, during low-tide, — during the nocturnal low-tides, naturally, it is dried up to a much lesser extent. As a rule, such a dried-up *Ulothrix*-vegetation is so tightly adpressed to the surface of the stone that it can only be removed by being scraped away with a knife. Thus, owing to desiccation, it appears, from a biological point of view, to have assumed a crustaceous form, which evidently diminishes the evaporation from its surface.

The other species which occur in great quantities in this association, such as *Urospora mirabilis* and *Monostroma groenlandicum*, act biologically in a similar manner to *Ulothrix flacca*. Both these species are found fairly frequently growing among *Ulothrix flacca*; and as I think that these species may in several respects be comprehended in one biological unity, I consider them members of the same association, although they both occur in pure growths (*Urosporetum*, *Monostrometum*).

While *Ulothrix flacca* and *Urospora mirabilis* are commonly distributed, the distribution of *Monostroma groenlandicum* is more restricted, for this species can be reckoned as commonly distributed only in E. Iceland.

Of the species which are rare or of local occurrence, and which are reckoned in this association, the following may be mentioned: *Ulothrix pseudoflacca*, *Ulothrix consociata* var. *islandica* and *Urospora Hartzii*. In addition, *Enteromorpha intestinalis* f. *micrococca* and *Rhizoclonium* occur here as they do in the *Prasiola*-community.

Of these species *Ulothrix consociata* var. *islandica* requires to be described most fully. It is very social, and grows in cushion-like masses higher up, as a rule, than the other species of the association. It appears to be protected from desiccation both by its manner of growth and by the thickness of its cell-walls.

Codiolum gregarium I have found to be of very social growth, covering comparatively large stones as pure *Codioleta*. It is most nearly related to this association.

The structure of the frond in this association displays various peculiarities, which must be considered as being beneficial to the plant during the period of desiccation: for instance, the interior of the frond of *Monostroma groenlandicum* is filled with a gelatinous

mass. Rosenvinge (63, p. 201) has pointed out that this mass must be of importance as a reservoir for water during low-tide. *Ulothrix flacca* also has very thick cell-walls, especially in the fruit-bearing filaments (cf. Rosenvinge l. c.). The remaining species also are rather thick-walled.

Although the *Ulothrix*-association is distributed to an extraordinary extent, yet it cannot be expected to be found everywhere. It prefers that part of the littoral zone which is rocky and stony, and grows luxuriantly on a somewhat exposed coast, and even, indeed, on one which is very exposed. It also extends right into the fjords, if the nature of the shore is favourable to it.

The succession of the associations of filiform algæ is seen most distinctly on vertical rocks on somewhat exposed coasts, where the *Ulothrix*-association appears uppermost; but where the substratum is uneven — a talus of debris or irregularly heaped-up fragments of rock — the zonal division of the community becomes less apparent, and it may then well happen that the *Bangia*-association extends above the *Ulothrix*-association.

The *Bangia*-association prefers the rocky part of the littoral zone, and vertical rock-walls in particular, and is only rarely found in the stony part of that zone; it occurs normally below the *Ulothrix*-association, but where the latter is absent the *Bangia*-association is not infrequently the algal vegetation which reaches highest. In many places it has an extremely wide horizontal distribution, and is often perceived at a considerable distance as a reddish-brown band in, and at the edge of, the water. This *Bangia*-belt may attain a considerable breadth, as much as three feet, and it often displays several shades of colour. Thus, in a less exposed spot facing the south, I have seen the uppermost part coloured green, the middle part brownish and the lowest part a fresh reddish-brown. This is certainly connected in some way with the long period of drought which, when the weather is calm or the wind blowing off the land, may well continue from neap-tide till about spring-tide. During the period of drought *Bangia* behaves somewhat similarly to *Ulothrix flacca*. The filaments are rather long, as long as 10 cm., and are very closely packed together; on vertical rocks they hang straight down during low-tide, and are, on the whole, protected by their structure and manner of growth from too severe desiccation, in the same way as has been mentioned in connection with the *Ulothrix*-association. The *Bangia*-belt is, as a

rule, distinctly separated from the *Porphyra*-association which exists below, but sometimes the two belts are concurrent, even over rather large areas.

The *Porphyra*-association is formed by *Porphyra umbilicalis* f. *typica*. It might be justifiable to incorporate this association in the *Bangia*-association, but I prefer to reckon it as a distinct association; partly on account of the difference in the form of its thallus, and partly because *Bangia* is confined to its narrow belt, while *Porphyra* occurs also in other associations in and below the *Fucus*-belt.

The *Porphyra*-association occurs on a rocky substratum. On vertical rock-faces it is very luxuriant, and then forms a continuous belt below the *Bangia*-association. Where the littoral zone has large fragments of rock, that is to say consists of a talus of debris, this species grows higher than any others upon the fragments at the water's edge. In such places no continuous belt is formed, but the species occurs in small scattered patches on the upper part of the blocks of stone. This patchy distribution of the vegetation may extend horizontally over either a small or a wide area, according to the form of the coast. The vertical height of the belt is always inconsiderable.

During the period of drought *Porphyra* hangs down on the vertical rock-faces, the thallus being repeatedly folded, according to its length; the individuals in the upper rows of the association often, to some extent, covering those below and thus, in some ways, recalling the behaviour of the above-mentioned filiform algæ; on the blocks of stone, also, the thallus is folded up in accordance with its length, and rests on the surface of the stone. The folding apparently serves to reduce evaporation during low-tide, as the evaporating surface is thereby diminished; the folding may well be of importance also in counteracting the effect of the light. As the folds of the thallus are produced while the water is subsiding, it is probable that some of this is retained between them, especially on a flat substratum; on a sloping or vertical substratum, however, the quantity of included water would be very small. This circumstance is probably of some importance, and has also been emphasized by Børgesen (12).

The *Porphyra*-association seems to maintain its freshness for a considerable time, and I saw it with its usual dark purple colour in several places in E. Iceland in the summer; but round about

Reykjavík, especially later in the summer, it frequently has a yellowish-brown tinge.

These associations, owing to local conditions, naturally are not found everywhere along the coasts. At times they are all present, and then generally in the succession here recorded; at other times only one or another is present. Thus, in some places, the upper limit of the marine algal vegetation is indicated by the *Ulothrix*-association, and in others by the *Bangia* or the *Porphyra* association; in places the entire community is absent, and then the boundary is marked by *Pelvetia*, *Fucus spiralis* or other *Fucaceæ*.

A comparison with the adjacent coasts shows that this community is found both in Greenland and in the Færøes though it does not behave in quite the same manner in both places. In Greenland a *Monostroma groenlandicum*-association is found which is composed of *Monostroma groenlandicum*, *Ulothrix flacca* and *Urospora mirabilis*, all intermixed with *Bangia fuscopurpurea*. This association occurs in the middle part of the littoral zone. A *Porphyra umbilicalis*-association occurs also in the upper part of the littoral zone. Thus, the same species occur in Greenland as in Iceland, although possibly they are not present in the same numerical proportion. But one great difference exists, namely that the Greenland community is found in the middle of the littoral zone, while the Iceland community is found much higher up. There is a similar difference in the occurrence of the *Porphyra*; as it is found in fissures of the rocks in the upper littoral zone in Greenland, while in Iceland it grows upon the surface of the rocks. This difference is probably due to a difference in the climate.

It is possible that the same community (Börgesen, 12, pp. 716, 719) may be found at an even greater height in the Færøes than in Iceland. In the Færøes the species are only partially similar, because *Monostroma groenlandicum* is wholly absent, and *Ulothrix flacca* does not seem to play such an important part there as it does in Iceland. The community of filiform algæ is, in all probability, common along the coast of Norway (Foslie, 18; Börgesen, 12, pp. 719—720; Boye, 10, p. 20).

3. The Community of *Fucaceæ*.

This community is the dominant one in the littoral zone and comprises six associations, of which the first two, the *Pelvetia*-association and the *Fucus spiralis*-association, are more closely

connected with each other than they are with the remaining associations, which also are mutually very closely connected. In this way the community may be divided into two belts, of which the first comprises the two first-mentioned associations, and the second the remaining four. The *Pelvetia-Fucus-spiralis*-belt is narrow. It is situated in the upper part of the littoral zone, at, and just below, lowest high-water mark, i. e. flood-mark at neap-tide. It has only one layer of vegetation, as there is no undergrowth worth mentioning, and it is entirely devoid of epiphytes; it is submerged in normal conditions for a very short time.

The second, the *Fucus*-belt is broad; it occurs in the lower part of the upper littoral zone, just above low-water mark of neap-tide. The vegetation occurs in two, and sometimes in three, layers and epiphytes are present in abundance. The vegetation is submerged much longer than in the first belt. Thus, these two belts differ so greatly that they cannot be treated together.

The *Pelvetia-Fucus-spiralis*-belt.

This belt is of common occurrence, and its vegetation is luxuriant in S. and SW. Iceland, but in the other parts of the country is sparse and devoid of *Pelvetia*. This belt is not continuous except along short distances, and its vertical height is inconsiderable: but the breadth may sometimes be fairly considerable, especially on very gently sloping coasts. It grows on rocky coasts, and in places where these consist of a talus of debris the vegetation is distributed in patches which is a natural consequence of the surface, the limit of the association being rather sharply defined downwards. *Pelvetia* and *Fucus spiralis* do not grow intermixed, but occur in two pure and distinct associations. They grow luxuriantly on exposed coasts: in the most exposed parts of the coast, however, they seem to recede. Thus, this belt was either absent from, or was poorly represented on the most exposed points at the extremity of Snæfellsnes and of the Vestmannaeyjar and at the extreme end of Reyðarfjörður; but there occurred in its place surf-forms of *Fucus inflatus* (f. *exposita* and f. *dendroides*).

The *Pelvetia*-association (Fig. 3) always occurs highest of all. As already mentioned it is found in S. and SW. Iceland only, but there it occurs in great abundance in many places; in some places its vegetation is poor, and sometimes only a few scattered individuals are found. This is more particularly the case in places where *Pelvetia*

appears to have extended too high upwards, and where, when the weather is calm, it is not wetted daily by the sea at and about neap-tide. On a warm summer's day *Pelvetia* can become so dry in such places that, when gathered, it needs no further drying — the same may also be the case with *Fucus spiralis*. The individuals of *Pelvetia* which grow at that height, i. e. sometimes right up in the *Verrucaria maura*-belt, are usually very small (about 2 cm. in height) and occur closely pressed to the rock; then they are often



Fig. 3. *Pelvetia canaliculata* above, *Fucus spiralis* below. Illustration of a typical *Pelvetia*-*Fucus-spiralis*-community. Reykjavík, Aug. 13, 1909. (From phot. by Hesselbo.)

found especially in crevices, and the new fronds may bear a surprisingly close resemblance to a rosette. Lower down, where the vegetation is luxuriant, the plants are about 8 cm. in height. *Pelvetia* is the smallest of the *Fucaceæ* on these coasts; it differs from the others not only by its small size, but also by its lighter, yellowish-brown colour, and its channelled frond, etc. The channelled frond must be useful to a plant which is so exposed to the desiccating action of the air as is the case with *Pelvetia*, because, by reason of their being rolled, the under-side of the fronds is less exposed to wind and weather.

It is characteristic of the zonal division of the *Fucaceæ* on the

coast that the smallest species (*Pelvetia*, *Fucus spiralis*) are arranged in a separate uppermost belt, while the larger species are arranged in belts lower down, and the largest species (*f. inflatus*, if the large broad-fronded forms are included) occurs lowest of all.

The *Fucus spiralis*-association (Fig. 4) is more luxuriantly developed than the *Pelvetia*-association and occurs just below it. On flat or very gently sloping rocks this association forms a comparatively broad belt, but on a steep coast only a narrow one. Its relation



Fig. 4. *Fucus spiralis*. Part of a luxuriant *Fucus spiralis*-vegetation below the *Pelvetia*-association. Reykjavík, Aug. 13, 1909. (From phot. by Hesselbo.)

to exposed coasts has already been discussed. It may happen with *Fucus spiralis*, as with *Pelvetia*, that it extends to so great a height that at times it is not wetted daily by the sea. In such a case the individuals are as a rule smaller, and are often rather strongly spirally twisted; they may be found lying quite dried up on the rocks, apparently without being damaged thereby. The twisting of the fronds may possibly result from the drying process.

This belt is, as a rule, somewhat sharply defined from the *Fucus vesiculosus*-belt situated below. Although it does not always happen that there is any distance worth mentioning between *F. spiralis* and the upper outposts of the *Fucus vesiculosus*-association, yet the boundary is almost always sufficiently distinct.

This belt behaves similarly in the Færøes (Börgesen, 12, p. 744). Both Boye (10) and Hansteen (25) mention a *Pelvetia*-formation from western Norway without mentioning *Fucus spiralis*. In Finmark *Fucus spiralis* has the same manner of growth as in Iceland (Foslie, 18, p. 66).

The Fucus-belt.

The four associations which belong to this belt are the most extensive in the littoral zone and three of them are found everywhere on rocky coasts. The breadth of the belt naturally is dependent on the degree of the declivity of the coast in addition to the nature of the substratum. This belt occurs everywhere along the coast, but it is not luxuriant to the same degree everywhere. Its vegetation is so dense that the bottom is entirely covered, or almost so, by the *Fucus* plants which during low-tide partly lie prostrate upon the rocks and partly hang on them; seen from a distance it appears as a brown-coloured belt of varying width along the coast. These associations are usually found on a rocky substratum, but they may also occur on a fairly firm gravelly bottom; the latter is especially the case at the head of the fjords. In such places their vegetation is poor and the species grow scattered, attached especially to small stones which are somewhat firmly embedded in the gravelly bottom. *Fucus* plants are also found scattered on wood-work, for instance, on wooden piles. On the whole the species of *Fucus* require a stable substratum. The dominant species are the following: —

Fucus vesiculosus.

Fucus inflatus.

Ascophyllum nodosum.

Fucus serratus.

The first three species are common and grow very luxuriantly along the coast; *Fucus serratus*, on the other hand, was found only in a few places in S. and SW. Iceland; in Hafnarfjörður it grew very socially, while in the Vestmannaeyjar it had a more scattered growth.

The individuals of these species form pure associations which usually occur in regular succession: *Fucus vesiculosus* growing uppermost, *Ascophyllum* in the middle and *Fucus inflatus* (and *Fucus serratus*) lowest of all. This succession is distinctly observable in places where the bottom is flat and gently sloping. But where the bottom is uneven — a talus of debris — the divisions between the belts are less regular, but can, as a rule, be discerned. It does not, however, follow that the associations always occur quite regularly;

the species being rather frequently found intermingled; the *Asco-phylum*-association, in particular, does not appear to be as spot-

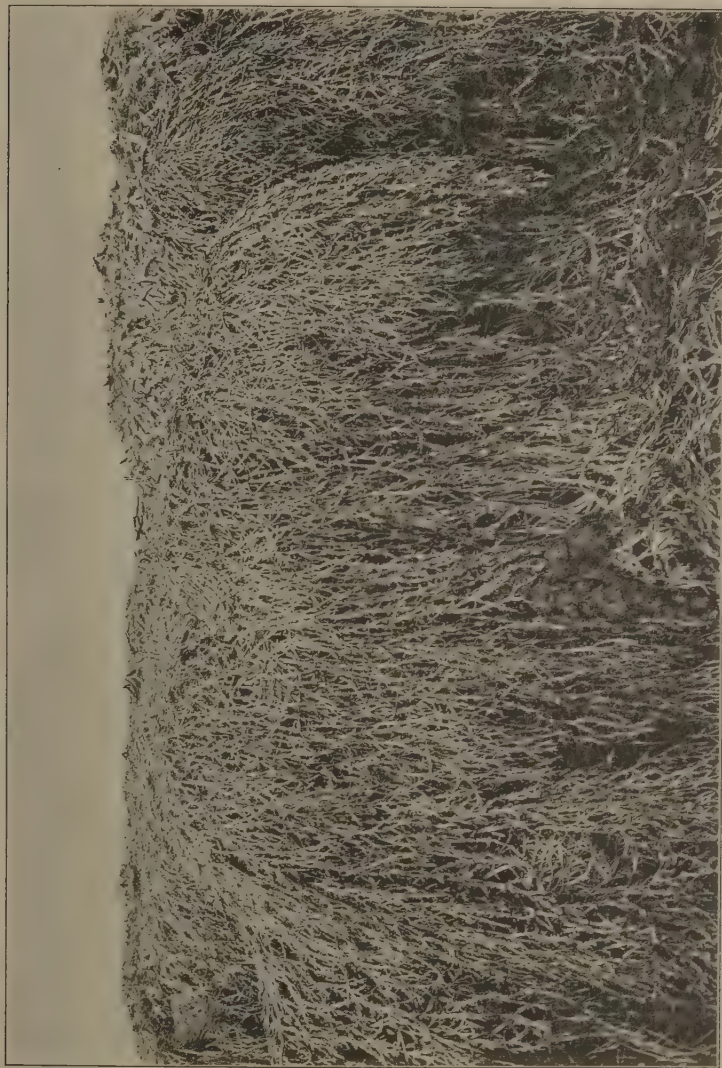


Fig. 5. *Asco-phylum nodosum*, with *Polysiphonia fastigiata* as epiphyte, hanging down on the rocks. Reykjavik, Aug. 13. 1909.
(From phot. by Hesselbo.)

bound as the others. It generally occurs somewhat below the middle of the area occupied by the community, but may occur also higher up, even at the very top. It is, however, a fairly constant fact that

Fucus vesiculosus grows highest and *F. inflatus* lowest. How the species behave when left dry is mentioned in connection with each association.

The *Fucus vesiculosus*-association, as already mentioned, is uppermost and often borders closely on that of *Fucus spiralis*. It varies extremely in extent, according to the character of the coast. The breadth may vary from about one foot on vertical rocks to several fathoms on a gently sloping coast.

Fucus vesiculosus extends right into the innermost part of the fjords, which is generally considered a protected coast; if there is a favourable substratum there, its growth may be fairly luxuriant. It also grows very luxuriantly on slightly exposed coasts, i. e. where a landward wind is sometimes both frequent and tempestuous, but where breakers are extremely rare. If the exposure is increased, it seems that *F. vesiculosus* not only decreases in number of individuals but also seeks for shelter between the rocks. Then, gradually, it retreats lower into the littoral zone, and *Ascophyllum*, which is evidently better able to withstand the heavy seas, advances. This is seen very distinctly at Reykjavík, where the coast must be considered somewhat exposed, because the south-west, west, and north winds are frequently stormy and occasion heavy seas. If we take a bay which is bounded by a rocky promontory, we see at the head of it a luxuriant *Fucus vesiculosus*-association; this extends out upon the promontory, growing gradually narrower as it extends outwards; in the vicinity of the point itself, the alga has commenced to seek for shelter, and at the extreme end of the point it has disappeared and *Ascophyllum* has occupied its place, and then *Fucus vesiculosus* is either found not at all or only a few individuals of it occur high up in the *Ascophyllum*-belt. What is here seen on a small scale is repeated on a larger scale on proceeding from the head of the fjord outwards to the extreme point of the peninsulas. Thus, *Fucus vesiculosus* was not observed on exposed points at Öndverðarnes (the extreme point of Snæfellsnes), while *Ascophyllum* and, naturally, *Fucus inflatus* also, were found in abundance. On the most exposed points of the Vestmannaeyjar *Fucus vesiculosus* was also absent, while both of the others occurred plentifully.¹ Thus, *Fucus vesiculosus* behaves in Iceland precisely as it does in the Færøes (Börgesen, 12, 11).

¹ Strömfelt (70) records *Ascophyllum* as growing above *Fucus vesiculosus* at Hólmanes in E. Iceland.

Generally this species forms a pure association, but yet, sometimes, it and *Ascophyllum* can grow intermixed.¹ It is always submerged at high-water, but seems well able to withstand desiccation at low-water, when however the upper side of the frond dries up considerably, especially on rocks which face the sun, and may then — and this is true of *Fucus inflatus* also — be bent upwards, or even slightly distorted, at the apex, though never to the same extent as is the case with *Fucus spiralis*. When such a branch is lifted up, it can be seen that the under side is moist, even on a warm summer's day. During low-tide the *Fucus* plants lie prostrate on the rock, one plant overlying the other, or one branch of the frond covering the other, and in this way some water is retained amongst the plants.

Naturally, this applies also to the members of the other associations in the *Fucus*-belt. Those individuals which hang freely from the rocks are exposed more than others to desiccation.

The *Ascophyllum*-association differs from the other associations in its light-brown colour, and, in addition, by the occurrence of *Polysiphonia fastigiata*, which grows very luxuriantly on it in S. and SW. Iceland; it is often somewhat singular to see the light-yellow *Ascophyllum*-belt with the numerous dark reddish-brown patches of *Polysiphonia*.

So far as the behaviour of the species during exposure to the beat of the waves is concerned I must refer to the above-mentioned remarks, and can only add that at times it may also occur in the most exposed places, but no longer in the uppermost belt. Here it gives place to the surf-forms of *Fucus inflatus* (f. *exposita*, f. *dendroides*), which form a narrow belt at the upper boundary of the *Fucus*-belt. *Ascophyllum* occurs, then, between this and the real *Fucus inflatus*-belt, which retains its usual position. In a few places, however, on the most exposed points, *Fucus inflatus* only is found.

The *Fucus inflatus*-association. When exposed, this species behaves conversely to *Fucus vesiculosus* and grows most luxuriantly on exposed coasts. Thus, it behaves in Iceland as it does in Greenland (Rosenvinge, 63) and in the Færøes (Börgesen, 12). In Iceland, as in other places, the species varies extremely and must be considered very capable of adapting itself to varying circumstances, especially as regards exposure. The association can — in accordance with the exposure — be divided into three belts: — The Surf-belt, the Wave-belt, and the Calm-belt.

¹ The epiphyte-vegetation is mentioned subsequently.

The Surf-belt, as previously stated, occurs at the upper boundary of the *Fucus*-association on rocky coasts which are very much exposed. I have seen such a belt at Øndverðarnes in SW. Iceland, in the Vestmannaeyjar in S. Iceland and at Vattarnes in E. Iceland. Strömfelt (70) has noticed a similar belt on Seley in E. Iceland. It will probably be found, on further investigation, that the surf-belt is far more widely distributed along the coasts than is recorded above. As a rule, the individuals in this belt are of low growth; the frond is leathery, and very thick in proportion below, and rounded, but tapering evenly upwards and becoming thinner: above, it is often excessively branched. The height of the individuals varies to some extent, f. *dendroides* is the highest, while f. *exposita* attains only an insignificant height (5–9 cm.). A similar surf-belt occurs in the Færøes (Börgesen, 12), although the vegetation is possibly more luxuriant there than in Iceland.

The Wave-belt (Fig. 6) comprises the ordinary *Fucus inflatus*-belt. As a rule, it is exposed to the movement of the waves, a movement which is often very violent indeed; more rarely it is exposed directly to the breakers. Here the species occurs in its typical form which shows a considerable variation in the breadth and consistency of the thallus. In very exposed places the branches of the frond are comparatively long and narrow and leathery, but where the movement of the waves is less felt, the frond is usually broader. The vegetation of this belt is generally very luxuriant, and covers the substratum entirely. Often, however, the vegetation occurs in patches, owing to the surface-features of the shore. Such a mode of occurrence is met with, for instance, where the shore is a wild talus of debris consisting of large scattered blocks of stone, or where the solid rock has a similarly uneven surface owing to erosion by the sea. There a belt is formed around each block of stone, while the hollows between them are occupied by semi-littoral or sublittoral vegetation, or by stragglers from these zones.

The Calm Belt is lowest of all, often at the boundary between the constantly submerged and the lower littoral vegetation, and sometimes forms small offshoots of vegetation¹ below that boundary. Here the movement of the waves is least felt, and the frond of the

¹ The species varies from the principal form to two kinds of dwarf-forms — a small "surf-form" of tough texture, and a small "pool-form" of delicate texture. The pool-form-association (*F. inflatus* f. *linearis*) may be regarded as the fourth belt, which should then be termed the Delicate Belt (see under The Vegetation of Tide-Pools, p. 125).

plants is also usually broader. In this belt the broad forms are to be found; they may occur both with and without air-bladders. This belt is as a rule poorly developed, and is often non-continuous. Within Hvammsfjörður, in bays protected from the surf, but where current-movements are felt to a certain extent, I have observed, below low-water mark, semi-littoral stragglers from the *Fucus*-community (i. e. from the *Fucus inflatus*-association). In a similar locality I saw *Ascophyllum* occurring semi-littorally.



Fig. 6. *Fucus inflatus* (sterile plants) lying prostrate upon the rocks. Above, hanging *Ascophyllum*. Reykjavík, Aug. 13, 1909. (From phot. by Hesselbo.)

The *Fucus serratus*-association was especially luxuriant in Hafnarfjörður on both sides of the fjord, some distance from the head of it, and occurred lowest of all in the *Fucaceæ*-community. In the Vestmannaeyjar the species grew scattered here and there, but was not found in the most exposed places. Sometimes on exposed coasts it was found growing in pools in the middle of the littoral zone.

The Epiphytes and Intermixed Species of the *Fucus*-belt. As is well known, an abundance of epiphytic vegetation exists in the *Fucus*-belt, at any rate at times. Many of the species grow socially and often occur in such quantities, that they set their stamp upon the vegetation. These species may be divided into those

which grow exclusively, or by preference, on the *Fucaceæ*, and those which occur as frequently on other substrata and must consequently be considered chance visitors.

Only one single species, *Polysiphonia fastigiata*, is exclusively confined to the *Fucus*-belt (Fig. 7). It is well known that this species grows only on *Ascophyllum nodosum*, into the frond of which it puts its rhizoids,¹ although its distribution does not coincide entirely with that of the latter. While *Ascophyllum* is common everywhere along the coast of Iceland, *Polysiphonia fastigiata* is common only in S. and SW. Iceland; it has been found, also, in a single place in NW. Iceland. Thus it keeps to the warmer parts of the sea off the coasts of Iceland, but even within this area it may be absent from coasts where the sea-water mixes abundantly with the fresh water. It did not occur for instance at Borgarnes, nor on the nearest islands, although *Ascophyllum* occurred in great quantities together with *Fucus vesiculosus* and *Fucus inflatus*. There the sea-water is freely mixed with water from the large glacier-torrent of Hvítá in Borgarfjörður. *Polysiphonia fastigiata* does not seem able to endure such water, but further out, along the fjord, where the water becomes more saline, it grows in the ordinary manner.

Of those species which grow by preference on *Fucaceæ*, *Elachista fucicola* and *Ulvella fucicola* may be mentioned. The first of these is the most important and often occurs in wonderful abundance, *Ulvella* forms a much less important part of the vegetation, more especially on account of its minute size.

Besides these two, other species frequently occur which just as often, or even more often, grow on other substrata. Of these *Pyraliella littoralis* plays a very important part in the vegetation, especially in the spring; then it sometimes occurs in such quantities that it almost covers large stretches of the coast. *Ulothrix flacca* also frequently occurs in great abundance, as may also be the case with *Isthmoplea sphærophora*. In spring and early summer *Ectocarpus tomentosus* and *Ectocarpus fasciculatus* are found growing together socially on *Fucus inflatus* (both of them in S. and SW. Iceland). *Ectocarpus confervoides* is also a rather frequent epiphyte. In addition, *Monostroma* and *Enteromorpha intestinalis* may be mentioned, on which, again, epiphytes can grow (as for instance *Chantransia*-species); also *Ulothrix pseudoflacca*, *Acrosiphonia*, *Ceramium rubrum*, *Ralfsia verrucosa*, *Conchocelis rosea*, *Porphyra umbilicalis* and others.

¹ Gertrud Tobler-Wolff, in Beihefte z. Botan. Centralbl., Bd. 24, 2. Abt., 1909.

It is usually the case that it is the older parts of the fronds which are most covered by epiphytes; this agrees well with the fact that the older fronds have a rougher surface than have the younger ones, and therefore retain the spores better. The epiphytes



Fig. 7. *Polysiphonia fastigiata* on *Ascophyllum* which is hanging on the face of the rock.
Reykjavík, Aug. 13, 1909. (From phot. by Hesselbo.)

on the *Fucaceæ* do not appear to arrange themselves in strata as do the *Laminaria*-epiphytes.

The intermingled species do not play any special rôle in the *Fucus*-belt, as regards the vegetation; they consist partly of species which grow on the *Fucaceæ* and partly of species which ordinarily grow outside the *Fucus*-belt. Of these species the following may be mentioned: —

Monostroma Grevillei.	Cladophora rupestris.
Ulothrix flacca.	Acrosiphonia.
Monostroma groenlandicum.	Enteromorpha intestinalis.
Pylaiella littoralis.	Porphyra umbilicalis.
Chordaria flagelliformis.	Chætomorpha tortuosa.

The Under-vegetation. This is found commonly distributed, and varies considerably, both as regards luxuriance and the species composing it. The luxuriance seems to increase with the degree of exposure (except perhaps in the most exposed places), and then the composition of the species is also changed, as species which primarily belong to a lower belt extend higher up, probably on account of the frequent movements of the sea which cause the desiccation-period to last but a short time. The undergrowth must be regarded as a kind of shade-vegetation; during low-tide it is completely covered by the *Fucaceæ*, and at high-water the intensity of the light is also subdued by them, as they float on, or rise with, the water, and are moved backwards and forwards by its ripples. The greater part of the species of the undergrowth do not occur at the height of the *Fucus*-belt in places open to the light, but occur frequently and abundantly in shaded localities, although these may be found at the upper boundary of the *Fucus*-belt as, for instance, in depressions in the talus of debris, upon the under side of overhanging blocks of stone. This vegetation may therefore be justly termed the shade-vegetation of the littoral zone. The species are normally developed and cannot be compared with the shade-forms of light-plants belonging to the land-vegetation. On the other hand, the shade-vegetation of the littoral zone actually corresponds with the shade-vegetation of the land, such as the fern-vegetation and the liverwort-vegetation in the lava-fissures.

The under-vegetation belongs in part to the shade-vegetation (see p. 123) and is divided into several associations; here it is dealt with under the *Fucus*-belt as its strictly littoral distribution almost coincides with that of the latter, and it is just as dependent on the upper-vegetation, or even more so, as is the undergrowth in a coppice. As regards the relation between the upper-vegetation and the undergrowth in the *Fucus*-belt the main advantage is, I think with the undergrowth; although during low-tide, the upper-vegetation may gain some advantage from the fact that the layer of living plants under it retains more water than does the bare surface of the rock.

The following species of the under-vegetation occur in such quantities that they form associations of considerable extent which are usually pure, but may sometimes be mixed: —

<i>Hildenbrandia rosea</i> . ¹	<i>Gigartina mamillosa</i> .
<i>Rhodochorton Rothii</i> .	<i>Ceramium rubrum</i> .
<i>Sphacelaria britannica</i> .	<i>Callithamnion Arbuscula</i> .
<i>Polysiphonia urceolata</i> .	

The *Hildenbrandia*-association is most extensively distributed, and is found everywhere along the coasts. It usually occurs as a pure association, though, in many places, *Verrucaria mucosa* is intermingled with it. *Hildenbrandia* may also occur at the same height outside the *Fucus*-covering, but is then — if the light is not subdued by other plants or projecting rocks — usually of a darker colour.

The *Rhodochorton*-association often covers extensive areas, like a dense, red carpet of felt. Most often it is pure, and appears, as far as its littoral distribution is concerned, to be confined mainly to the shady parts of the littoral zone. A few of the other shade-species may be found intermingled with it in small numbers, which fact is of minor importance, whereas the occurrence of the epiphyte *Pleurocapsa amethystea* is of great importance, as this species is found only on *Rhodochorton Rothii*.

R. Rothii does not occur below the *Fucus*-belt of the littoral zone until it occurs again at a considerable depth on *Laminaria* stems; thus it is found in two distant belts: the shade-belt of the littoral zone and the *Laminaria*-belt.

A *Sphacelarietum* (*S. britannica*) occurs almost quite pure in many places over rather large surfaces; it forms a dense covering on the rock as does *R. Rothii*. *Sphacelaria radicans*, *Polysiphonia urceolata* and *Rhodochorton Rothii* occur intermingled.

Polysiphonietum. *P. urceolata* occurs in a similar manner, covering rather large surfaces of rock. In places where the species forms extensive mats, it is usually very low in growth, yet always considerably higher than *Rhodochorton Rothii*. A thin layer of fine clay may often be seen to have accumulated between its basal parts.

A *Gigartinetum* occurs as under-vegetation, especially in more exposed places, and is then generally found in the lowest part of the *Fucus*-belt or in the *Fucus inflatus*-association; it is a direct continuation upwards of the *Gigartina*-association below.

¹ Arranged in accordance with the frequency, the most frequent coming first.

In addition *Ceramieta* formed by *Ceramium rubrum*, and *Callithamnioneta* formed by *Callithamnion Arbuscula*, occur distributed in patches, especially in the Vestmannaeyjar.

The following species, growing in a more scattered manner, occur also in the under-vegetation of the *Fucus*-belt: —

Delesseria alata.
Lithothamnium.

Plumaria elegans.

The species of the under-vegetation thus belong principally to the red algæ; only two species being brown, one blue-green and one being a lichen. The majority of the species belong to the shade-vegetation of the littoral zone.

4. The *Enteromorpha*-association.

Of the *Enteromorpha*-species *E. intestinalis* is the most common and the most variable. The variability, no doubt, principally depends upon local conditions, possibly also, on the age of the species. The typical form is extremely common in the upper littoral zone, but occurs most luxuriantly in the water-filled depressions. As a rule, the plants have a social growth, although they rarely cover large areas. *E. prolifera* and *E. clathrata*, on the other hand, occur in such abundance that it might be justifiable to speak of an association formed of branching *Enteromorphas*. These species are found in greatest abundance in the middle littoral zone, often in empty depressions in the lower part of the *Fucus*-belt proper, and may sometimes extend beyond the boundary of the lower littoral zone, where they then encounter semi-littoral associations, for example, *Dictyosiphonietum*, *Chordarietum* and others. While the typical form of *E. intestinalis* seems to flourish during the spring, the branching forms *E. prolifera* and *E. clathrata* are noticeable in the summer. I have known these two species to occur predominantly in June, July and August on the same substratum upon which *Urospora Wormskioldii* was growing in great quantities in the month of May.

Enteromorpha Linza is also a summer species, and, although it forms in several places pure *Enteromorpha* of lesser extent, plays only an inferior rôle in the *Enteromorpha*-association.

In E. Iceland, on the point between Seydisfjörður and Loðmundarfjörður, at the height of the lower part of the *Fucus*-belt and a little lower, I found a *Chlorophyceæ*-vegetation which must be considered to belong most nearly to this association. A *Monostro-*

metum of *Monostroma groenlandicum* was here found in abundance, often entirely covering the boulders and occurring on them, like *U. flacca*, closely pressed to the stone-surface with a radiating arrangement. In addition, an abundance of *E. intestinalis* f. *compressa* and a few *Ulothrix flacca* were found. A little lower down, a *Urosporetum* (*U. Wormskjoldii*) occurred, which can scarcely be separated from this association; it seemed to form a connecting link with the semi-littoral communities.

Cladophora gracilis occurred intermingled in the *E. clathrata*-association, yet without playing any important rôle in the vegetation.

A similar association, especially an *Enteromorphetum* of *E. intestinalis*, is, beyond doubt, very common in other countries. It seems to be more poorly developed in Greenland (Rosenvinge, 63, p. 205) than in Iceland; in the Færøes (Börgesen, 12, pp. 714, 715), on the other hand, the *Enteromorpha intestinalis*-vegetation seems to be more luxuriant than in Iceland.

5. The *Acrosiphonia*-association.

This association consists of decidedly filiform, much branched algæ, which grow very socially. During the period of desiccation they retain the water as a sponge retains it. This circumstance is mentioned with regard to some of these species by Rosenvinge (63, p. 202), who says of *Cladophora arcta* (= *Acrosiphonia incurva*, cf. Jónsson, 32, p. 43) that in Greenland it behaves during low-tide like a sponge saturated with water.¹

The principal species in this association are *Acrosiphonia albens* and *A. incurva*. They form individually, pure *Acrosiphonieta* in the upper and lower littoral zones, where they cover flat stones with a densely matted vegetation. On flat rocks the association may be somewhat widely distributed, in other places it has more the character of scattered *Acrosiphonieta*. The density of the vegetation is due to the structure of these species. As the basal part of the principal axis is too weak to carry the plant when its branch-system has developed, lateral rhizoids, which slope downwards, are developed at an early stage from the principal axis itself and from the lower branches. These rhizoids often form creeping filaments from which arise erect shoots, which can be detached from the parent-plant and thus become independent individuals. The principal

¹ Possibly this is the case in an even higher degree with *Callithamnion Arbuscula* (cf. Börgesen, 12, p. 726).

axis dies away from below and in this way branches, or systems of branches, with well developed rhizoids are detached from the parent-plant and become independent individuals (cf. Jónsson, 32). The rhizoids of one individual become entangled with those of others, and in this way the basal parts of the entire vegetation become matted together. In addition to this, the lower branches are hook-shaped, or bent downwards and outwards; thus it easily happens that they are entangled between the branches of other individuals, which further increases the matted condition. The upper branches are directed obliquely upwards, without being entangled with the branches of other individuals.

An *A. albescens*-association occurs everywhere along the coasts, but on very exposed coasts the species generally grows dispersed. Here it occurs in separate tufts which are, no doubt, composed of several individuals, densely matted together below, but branching upwards in various clusters, which are themselves densely matted together by their hook-shaped branches; the branch-systems above are, as usual, free. These characteristically matted branch-clusters are probably an effect of the heavy beat of the waves; the matted *Acrosiphonia* "tufts" will not be able to resist the force of the waves and, even at an early stage, will become divided into very densely matted branch-clusters.

Acrosiphonia albescens occurs both in the upper and the lower littoral zone, while *A. incurva* belongs to the lower littoral zone, but yet also extends upwards into the pools of the upper littoral zone, and below low-water mark.

Spongomorphetum. *Spongomorpha vernalis* grows very socially, but never forms such a dense vegetation as does *Acrosiphonia*, although it is sufficiently dense to characterize the spot. The species has been found in only a few places; it occurs in abundance at Gróttá, where it grows both on a stony substratum and also as epiphytic vegetation in the *Corallina-Gigartina*-belt and in the *Polysiphonia urceolata*-association of the lower littoral zone.

A Cladophoretum formed of *Cladophora sericea* f. (see under Tide-Pools) also belongs to this association. It forms a densely matted belt in pools high up in the upper littoral zone. As a rule it follows the edge of the water round the entire pool.

Cladophora rupestris ought also to be considered to belong to the *Acrosiphonia*-association.

An association similar to the *Acrosiphonia*-association is, no

doubt, very common in adjacent lands. During low-tide the uppermost free branches appear to be more exposed to desiccation and possible death in Greenland than in Iceland; in the latter place it occurs rather frequently. Both in Greenland (Rosenvinge, 63) and in the Færøes (Börgesen, 11, 12) the *Acrosiphonia*-association is well represented.

bb. The Shade-vegetation.

To this vegetation are referred certain littoral associations which occur exclusively in shady places. The shade is produced by the light being subdued both by a covering of living plants and by projecting blocks of stones. Thus the greater part of the under-vegetation-associations of the *Fucus*-belt mentioned above belong to the shade-vegetation. In addition, the shade-vegetation grows, as already mentioned, on the under side of overhanging rocks — on their in-sloping sides. The vegetation is divided into several associations which have already been mentioned in connection with the under-vegetation of the *Fucus*-belt (cf. p. 118).

The frond differs in form and structure in the various species of this vegetation. It is a feature common to the whole of the shade-vegetation to be low and dense in growth. The frond of *Hildenbrandia* is a crust which covers the rocks; the others are finely branching; some, as *Sphacelaria* and *Polysiphonia* are bush-like and are richly and finely branched; *Rhodochorton* has a similar mode of branching, but to a considerably less degree. These three species often propagate vegetatively by means of runners, which increases the density of the vegetation. *Plumaria* is closely and distichously branched; it is tightly adpressed to the surface of the stones during the time of low-tide and retains much water between its branches, considered from a biological point of view it might almost be regarded as leaf-like during the period of desiccation.

6. The *Hildenbrandia*-association belongs almost exclusively to the under-vegetation of the *Fucus*-belt, and of the shady localities in the littoral zone (see above, p. 118).

7. In shady places the *Rhodochorton*-association, the *Sphacelarietum britannici*, and the *Polysiphonietum urceolatae* behave in a similar manner outside the *Fucus*-belt as they do within it (see above). They may occur either as pure as-

sociations, and are then dominant here and there in patches, or the species may be found intermingled with each other. Besides these associations a *Plumarietum*, consisting exclusively of *Plumaria elegans*, is found in many places. This association is darker in colour than the other red-algæ associations of shady places; it occurs frequently in S. and SW. Iceland. Intermixed in it occur *Callithamnion scopulorum* and *Chantransia virgatula*.

Rhodochorton Rothii is sometimes found high up in the littoral zone on flat rock-surfaces exposed to the light and to the beat of the waves, but then it grows in small globular cushions (*f. globosa*). Consequently, this globetum of *Rhodochorton Rothii* does not belong exclusively to the shade-vegetation.

On flat surfaces in the shade the usual arrangement is that the decided shade-associations occur at the bottom, where the light is feeblest, e. g. the *Sphacelarietum*, *Rhodochortonetum*, *Polysiphonietum*, *Plumarietum*; at the top, where the illumination is stronger, light-loving species occur, e. g. *Pylaiella*, *Ulothrix*, or others. Near Reykjavík a vertical section of such a surface showed uppermost, at the edge, *Pylaiella littoralis*, next *Rhodochorton Rothii f. globosa*, and lowest of all *Plumaria elegans*.

In a grotto in the Vestmannaeyjar, where the illumination was very feeble, *Enteromorpha intestinalis f. micrococca* occurred on the roof, *Ceramium acanthonotum* grew rather high up on the walls, and *Plumaria elegans*, together with *Delesseria alata*, formed a belt lower down the walls.

A vegetation corresponding to the shade-vegetation appears to occur in Greenland where *Hildenbrandia rosea*, *Ralfsia clavata* and *Verrucaria mucosa* form the undergrowth in the *Fucus*-belt and in other places (Rosenvinge, 63, pp. 198 and 203). *Rhodochorton Rothii* and *Sphacelaria britannica* also appear to grow in a similar manner in Greenland (Rosenvinge, 63, p. 205).

A comparison with the Færøes shows some difference. The vegetation in the grottoes in the Færøes (Börgesen, 12, p. 739), however, resembles in its main features the Iceland shade-vegetation, and, in addition, a similar vegetation is beyond doubt to be found in fissures and clefts of the rocks in the Færøes, but the mode of occurrence of the species is not the same. Thus, in the Færøes (Börgesen, 12, p. 711), the *Hildenbrandia*-association appears to have a much wider distribution upwards and to occur in fully illuminated localities. *Rhodochorton Rothii* seems to occur in a similar manner

in the Færøes (Börgesen l. c., p. 718) as it does in Iceland, with this difference, however, that the species extends higher upwards in the Færøes and, also, frequently grows in fresh-water in the latter place.¹ *Sphacelaria britannica* grows similarly in the Færøes (Börgesen, 13, p. 432).

According to Foslie (18) a similar shade-vegetation appears to occur in northern Norway.

This vegetation is a natural upward continuation of the semi-littoral *Polysiphonia urceolata*-association mentioned below.

cc. The Vegetation of Tide-Pools.

Where there is a rocky coast, depressions of varying sizes occur everywhere in the littoral zone. These depressions may be divided into two groups: The tide-pools of the upper littoral zone, and the tide-pools of the lower littoral zone. The plant-growth in these tide-pools does not form a vegetation-unit, and is chiefly composed of species either scattered or of social growth which belong to the littoral or semi-littoral communities; they are, however, here treated separately in order to further characterize the illustration of the littoral zone given in the above description.

Tide-Pools of the Upper Littoral Zone. Of these the uppermost, which are almost on the level of *Fucus spiralis*, are of the greatest interest, as they often contain species, or forms of species, which do not occur elsewhere in the littoral zone. These species are *Cladophora sericea* f. and *Fucus inflatus* f. *linearis*.

The water in the uppermost pools is not replenished with the recurrence of each high-tide, and this is especially the case in calm weather during neap-tide; if, simultaneously, dry weather occurs, the water evaporates, and this the vegetation cannot endure for any length of time. In rainy weather, on the other hand, the pools are filled with fresh water, and should this happen during neap-tide the salinity would be insufficient for any of the species to exist. At spring-tide the water in the pools becomes mixed with a fresh supply of sea-water, and the vegetation then lives, for a time, under good conditions. Thus, there are times during which the conditions in the pools are not favourable to algal life.

Cladophora sericea grows very socially in many places and, in

¹ When I visited the Færøes in October, 1897, I was at first surprised to find *R. Rothii* growing in streams at and above the upper limit of flood-tide; such a situation for it in Iceland was unknown to me.

small pools, often forms a continuous fringe, the upper branches either reaching to or lying on the surface of the water. In such pools *Chætomorpha tortuosa* sometimes occurs in fair abundance loose upon the surface of the water; its filaments are usually densely matted together.

Fucus inflatus f. *linearis* grows even more socially. At times it is almost the dominant species in the smaller pools, although, rather frequently, several other species are found intermingled with it. This form is a biological variety of *Fucus inflatus* which, in the pools, exists evidently under less favourable circumstances; this is one cause of its small size and feeble structure, although another is that it is not exposed, to any extent worthy of mention, to the beat of the waves. Rosenvinge has especially shown this to be the case as regards Greenland. Rosenvinge explains the frequent occurrence of this form in the pools by the fact that the eggs of *F. inflatus* are carried into the water-filled depressions by the movement of the water and accumulate there. This explanation is undoubtedly correct, and, as Rosenvinge points out, all intermediate stages between the feeble pool-form and the typical form can be demonstrated. To any one who has seen this endless variation in nature, it seems so certain that it is due to the influence of outside factors, that experimental proof is almost superfluous. *

The uppermost pools are generally extremely poor in species; and, besides those already mentioned, only *Enteromorpha intestinalis* occurs in any great abundance. Where the coast is exposed, the uppermost pools may, however, have a resemblance to the lower ones of the upper littoral zone — a natural consequence of the exposure. On more exposed parts of the coast a fringe of small *Monostroma Grevillei* is often found, almost on the surface of the water itself. At one place in E. Iceland I took the temperature of such a submerged plant-covering, and the thermometer showed 20° C. (June 13). The vegetation was also somewhat injured, and evidently did not prosper under these conditions.

High up on a rocky coast to the south of Vattarnes in E. Iceland, I came across a pool-vegetation. I did not measure the altitude of the spot, but I do not think that I was greatly mistaken in estimating it at 70—100 feet above sea-level. As regards the place, I noted in my diary — “High rocky coast, land-plants grew round the alga-pools. The water in the pools must be replenished with rain and heavy surf, which sometimes fail for long periods during

the summer. Many pools filled with decaying and dying algæ." The occurrence of algæ so high up can be imagined only on a very exposed coast facing the open sea, and even there it would be exceptional.

The dominant species of the vegetation in these high-lying pools consisted of *Fucus inflatus* f. *linearis*. Intermixed occurred *Chaetomorpha Melagonium* — which I never before had seen so high above sea-level — *Acrosiphonia* sp., *Dictyosiphon foeniculaceus*, *Pylaiella littoralis* and *Enteromorpha intestinalis* f. *typica*. The undergrowth consisted of *Hildenbrandia rosea*.

In another somewhat elevated and exposed place in the vicinity of Vattarnes, a number of small pools were found just below the *Verrucaria maura*-belt. *Hildenbrandia* and *Verrucaria mucosa* grew on stones at the bottom of these pools; in addition, *Fucus inflatus* f. *linearis* occurred fairly abundantly, although dying in the pools, which were deficient in water.

The lower pools in the upper littoral zone have a much more luxuriant vegetation. Here various littoral and semi-littoral species can grow in fair abundance. The water in these pools is replenished at each high-water, so here, the plants exist under fairly favourable conditions. The following species may occur dominantly or abundantly: — *Fucus inflatus* f. *linearis*, *Halosaccion ramentaceum*, *Monostroma fuscum*, *Enteromorpha intestinalis*, *Monostroma Grevillei*, *Dictyosiphon foeniculaceus* and *Castagnea virescens*.

Many species are found growing scattered, of which the following are most frequently met with: —

<i>Polysiphonia urceolata</i> .	<i>Phyllitis fascia</i> .
<i>Porphyra miniata</i> .	<i>Pylaiella littoralis</i> .
<i>Rhodomela lycopodioides</i> .	<i>Scytosiphon Lomentaria</i> .
<i>Rhodymenia palmata</i> .	<i>Chaetomorpha Melagonium</i> .
<i>Chorda Filum</i> .	<i>C. tortuosa</i> .
<i>Chordaria flagelliformis</i> .	<i>Cladophora gracilis</i> .
<i>Coilodesme bulligera</i> . ¹	<i>Monostroma undulatum</i> .
<i>Ectocarpus confervoides</i> .	<i>Ulothrix flacca</i> .
<i>Elachista fucicola</i> .	<i>Urospora Wormskioldii</i> .

The under-vegetation often consists of *Ralfsia deusta*, *Lithothamnion circumscriptum* and *Hildenbrandia rosea*.

Taken on the whole, the majority of the littoral species undoubtedly may be met with in the pools, and it should be especially

¹ It may be observed, as regards *Coilodesme*, that it is the more inflated the lower the water is in the pools.

noted that, when the semi-littoral species occur in the upper littoral zone, they are usually confined to the pools, a fact which proves that they do not essentially belong to the upper littoral zone.

b. The Semi-littoral Zone.

The upper boundary of this vegetation is just at the lower boundary of the *Fucus*-belt. The vegetation covers the lower littoral zone, and extends, usually in the form of stragglers, below the limit of low-tide, down between the uppermost extensions of the vegetation of the *Laminaria*-belt, which in many places reach right up to the limit of low-tide. The semi-littoral communities consequently grow side by side with the *Laminaria*-associations below the limit of low-tide, to a depth of about 10 metres; they also occur as epiphytic vegetation on the *Laminariæ* at the depth mentioned.

Thus, the semi-littoral zone is that between the lower edge of the *Fucus*-belt and the *Laminaria*-belt. The breadth of the zone depends on the slope of the coast. If the coast is steep the zone is narrow, but if the coast slopes gently, it is broad. In this zone no single dominant community of extremely social and large species occurs, like, for example, the *Fucaceæ*-community in the littoral zone, and the *Laminariaceæ*-community in the sublittoral zone. The zone appears to lie too low for *Fucaceæ* and too high for *Laminariaceæ*.

Green and brown algæ occur in abundance in the semi-littoral zone, but the *Rhodophyceæ* are most richly represented. The semi-littoral associations occur both laid bare during low-tide and also continuously submerged to the depth mentioned.

It is easy to follow the upper boundary of the zone, even in places where the *Fucaceæ* are absent. The lower boundary can also be ascertained with comparative ease, if the large *Laminariæ* only are followed, and if the observer is not led astray by the small *Laminariæ*, which may occur in the depressions and pools of the lower littoral zone.

The semi-littoral zone comprises several associations which play a rather considerable part in the vegetation.

By authors who describe the algal vegetation on coasts where there is a change of tide these associations are generally considered to belong partly to the littoral and partly to the sublittoral vegetation. On coasts where there is no tide, the littoral vegetation has,

however, been subdivided. Reinke (58, p. 10) divides the littoral region near Kiel into an upper zone which is always laid bare at low-water, and a lower zone at a depth of 2—4 metres. So far as I can judge from the species enumerated, Reinke's upper zone corresponds approximately with the previously mentioned upper littoral zone, while the lower zone corresponds only in part with the semi-littoral zone here described. Gran (24, p. 11) records under the term "sublittoral vegetation" transitional formations which evidently, for the most part belong to the semi-littoral communities.

On the west coast of Sweden (Kylin, 45) the border-line between the littoral and sublittoral algal vegetations is, on the coast of Bohuslän, at a depth of 3—4 metres, and at Halland at a depth of about 5 metres. The upper part of the littoral zone seems to correspond to some extent with the above-mentioned upper littoral zone, while the lower part has something in common with the semi-littoral zone.

Where there is no tide, the boundary between an upper and a lower littoral zone is not, I think, so sharply defined.

8. The *Monostroma*-association.

This vegetation is composed of relatively large, membranaceous, green algæ. *Monostroma fuscum* and *M. Grevillei* form associations in a rather considerable number of places in protected localities in the fjords, below the limit of low-tide, and to a depth of at least 4—6 metres. There, the association is most sharply defined, although it is fairly frequently found intermingled with other semi-littoral associations. In the lower littoral zone also, an abundant *Monostroma*-vegetation frequently occurs, both on a rocky substratum, and also very often as epiphytic vegetation in other associations, as, for example, the *Halosaccion*-association, the *Corallina*-association, the *Polysiphonia urceolata*-association and others. In water-filled depressions in both the upper and lower littoral zone the *Monostroma* species often occur abundantly.

Monostroma Grevillei var. *arctica* seems to belong more immediately to the littoral zone. In many places it is found entirely laid bare, sometimes on a clayey substratum, when it often attaches itself to small individuals of *Mytilus edulis*, and sometimes where the substratum of the littoral zone is pebbly. During April and May this vegetation is rather characteristic, because then, the species occurs for the greater part in the inflated stage. The bladders vary

greatly in size and form and may be at times considerably elongated, bearing then a striking resemblance to an *Enteromorpha*. Under calm conditions the inflated stage continues until the spores at the apex of the frond are ripe.

In several places in the fjords *Monostroma Grevillei* var. *typica* forms a luxuriant, characterizing vegetation at a depth of about 3—5 metres.

Monostroma fuscum very frequently forms associations of considerable extent in the fjords at a depth of about 4 metres. The specimens of this species which occur there are generally very large (*f. grandis*). These large specimens are rather frequently found at low-water mark, detached or floating at the water's edge, and then it may generally be taken for granted that a *Monostrometum* exists further out at a depth of about 4 metres.¹ Both in the fjords of E. Iceland and in Eyjafjörður in N. Iceland this *Monostrometum* occurred in the same characteristic manner, viz. alternating with a *Chordarietum*, a *Dictyosiphonetum* (*D. foeniculaceus*), a *Halosaccione-tum*, and a *Rhodymenietum*. Generally the order was that *Rhodymenia* grew deepest (as deep as 12 metres), and *M. fuscum* most frequently uppermost (at about 4 metres). *Alaria* and *Laminaria saccharina*, in addition, may be found growing scattered in such places, which makes the character of the vegetation still more heterogeneous.

Monostroma undulatum does not occur so abundantly as do the other *Monostroma* species. It is found growing rather luxuriantly, however, in pools in the lower littoral zone, and on the stems of *Laminaria* in comparatively low water.

Ulva Lactuca, also, is most nearly related to this association.

This association is very common in the Færøes (cf. Børgesen, 12, pp. 731 and 764), and occurs also in Greenland (Rosenvinge, 63).

9. The Chorda-association.

This association is composed of rather large, brown algæ. The fronds are either non-branching, thick filaments (*Chorda*, *Scytosiphon*), or else branched, as in almost all the others; one, *Coilodesme*, however, is almost leaf-like.

This association has an insignificant distribution, and is found usually in patches, where the substratum is clayey or somewhat muddy. It occurs both in the lower littoral zone above low-water mark, and to a depth of at least 4—6 metres. The members of the

¹ Strömfelt (70, p. 11) mentions this *Monostrometum* at Eskifjörður.

association are as follows: — *Chorda Filum*, *C. tomentosa*, *Chordaria flagelliformis* and *Dictyosiphon foeniculaceus*. *Scytosiphon Lomentaria*, *Castagnea virescens* and *Coilodesme bulligera* are also most nearly related to this association. Some of the species occur in such abundance that they may be said to form an association; this applies more particularly to *Chorda Filum*. A pronounced *Chorda Filum*-association occurs in many places at a depth of almost 3—4 metres (measured during low-water of spring-tide). The individuals are extremely long, about 6 metres and, to a great extent, float on the surface at low-tide. The substratum is, as a rule, clayish with pebbles here and there. This association is often almost pure, but scattered individuals of *Laminaria saccharina* are not rare, although they play no essential rôle in the vegetation. *Chorda Filum* also grows above low-water mark in the lower littoral zone, but there it does not really form associations, although it may grow luxuriantly in many places.

Chorda tomentosa is also social and grows more luxuriantly below low-water mark than above it. It often occurs in abundance as a component of the sublittoral vegetation.

Chordaria and *Dictyosiphon foeniculaceus* are species which grow socially, and rather frequently a *Chordarietum* or a *Dictyosiphonetum* is found, usually with a limited distribution both below low-water mark and above it, especially in water-filled depressions in the littoral zone. The remaining species which have been mentioned are also of rather social growth in many places, both below and above low-water mark, especially in pools. *Coilodesme*, for example, was rather frequent in tide-pools in E. Iceland, and sometimes at a very high level, but then the individuals were frequently inflated; in SW. Iceland the species grew at and below low-water mark in company with *Chorda Filum* and *Saccorrhiza*.

With the exception of the above-mentioned *Chorda Filum*-association, this vegetation occurs usually in patches, distributed between other associations. Thus it is closely connected with the *Enteromorpha clathrata*-association at the boundary between the upper and lower littoral zones, and with the *Rhodymenia*-association and the *Monostroma fuscum*-association at a depth of about 4 metres, as has been previously mentioned.

In the Færøes a similar vegetation occurs as a part of the *Stictyosiphon*-association (Börgesen, 12, pp. 762—763).

10. The Community of *Rhodymenia*.

The species are *Rhodymenia palmata* and *Halosaccion ramenlaceum*, both of which occur along the coasts in great abundance as pure associations. These two associations most frequently accompany each other, and seem to demand somewhat similar conditions of life. *Halosaccion*, however, extends the higher up in the littoral zone, but is then almost always submerged in water-filled depressions in that zone, while *Rhodymenia* extends the further down below the limit of low-tide. In *Rhodymenia* the form of the thallus is leaf-like and branching; in *Halosaccion* it is round and excessively or slightly branching.

The *Rhodymenia*-association. On regarding a steep rocky coast, where the succession of the associations is always most easily observed, it is seen that a luxuriant *Rhodymenia*-vegetation commences even at the lower boundary of the *Fucus*-belt. In many places the species occurs so socially that it predominates as a characterizing plant over relatively large stretches, both in the lower littoral zone and far below the limit of low-tide, to a depth of about 12 metres. On a gently sloping rocky coast, the upper boundary of the association is not so sharply defined, but if proper allowance is made for the depressions and elevations in such a littoral zone the boundary is fairly easily ascertained although it may then lie in very many curves. On a gently sloping pebbly coast, the same regular boundary is found as on a steep rocky coast and at about the same height, although the *Fucaceæ*-community is not present there.

Various algæ may occur on stones under the fronds of the *Rhodymenia*, as, for instance, *Hildenbrandia rosea*, *Ralfsia clavata*, *Sphacelaria radicans* and others; also a number of epiphytes, especially *Myrionemaceæ* and *Ectocarpaceæ*, often grow on old individuals of *Rhodymenia palmata*.

Rhodymenia occurs also epiphytically on the stems of *Laminaria* in the upper part of the *Laminaria*-belt.

The *Rhodymenia*-vegetation does not seem to be so luxuriant in Greenland (Rosenvinge, 63) as in Iceland. Possibly this is true also of the north of Norway (Foslie, 18). In the Færøes the *Rhodymenia*-vegetation is luxuriant, but seems to differ somewhat from that of Iceland, as it consists of a form with lower and more dense growth and narrower branches; this form also extends further up (Börgesen, 12, p. 727).

The Halosaccion-association also commences below the lower boundary of the *Fucus*-belt, and extends from there to a depth of about 5 metres below low-water mark. The species grows very socially, entirely covering the rocky substratum upon which it grows; it is very variable, and, while *f. densa* seems to extend rather high up, in pools in the littoral zone, it is *f. robusta* which, as a rule, reaches to the greatest depth. *F. subsimplex* is very common just below the *Fucus*-belt, where it grows so densely that it covers the substratum completely. It is very often interwoven with byssal-threads of *Mytilus edulis*. In this form, as in the laid-bare *f. robusta*, inflated shoots occur fairly frequently. As is the case with *Rhodymenia palmata*, this species is very frequently decoloured in the lower littoral zone; yet in both species the lower part of the frond is, as a rule, reddish in colour.

Of the epiphytes, *Elachista fucicola* is especially frequent, and various other species may also occur closely applied to *Halosaccion*, such as *Porphyra miniata*, *Monostroma fuscum*, *M. Grevillei* and others. At times the *Monostroma* species may be so abundant that they may be said to play a distinct rôle as epiphytic vegetation. Among the *Halosaccion* individuals, *Dumontia filiformis*, *Chaetomorpha Melagonium* and others often occur growing scattered at the very limit of low-tide.

A similar Halosaccion-vegetation occurs in northern Norway (Foslie, 18), and probably on the arctic coasts as well (Kjellman, 36; Rosenvinge, 63). In the Færøes the association is poorly represented (Börgesen, 12, 13).

11. The *Polysiphonia urceolata*-association.

At and about low-water mark in the lower littoral zone, an association is found consisting principally of excessively branching, red algæ which I will name after the species *Polysiphonia urceolata*, which is dominant in the association. This vegetation frequently occurs on a flat or convex substratum of rock (lava-substratum) and often forms, especially in SW. Iceland, for example at Grotta near Reykjavík, a broad belt around *Corallina*-pools, near low-water mark.

The species which occur in greatest abundance in this association are *Polysiphonia urceolata*, *Cystoclonium purpurascens* and *Rhodomela lycopodioides*.

The *Polysiphonia urceolata*-association is very luxuriant

in many places at about low-water mark, and often covers rather large stretches of rock with a dense but, at times, low vegetation. As previously mentioned, it grows luxuriantly on flat rocks, without any protection whatever during the period of exposure, which is certainly short, and indeed exceedingly short during a heavy sea. Here, as in the upper littoral zone, the association occurs also on the face of the rocks, and the species seems as a rule to be larger than when on flat rocks. The association appears to have an extended vertical distribution since, as previously mentioned, it occurs as shade-vegetation or undergrowth in the upper littoral zone; furthermore it must be assumed that it has a larger sublittoral distribution than is shown by the dredgings, as it has been found outside the 10-metre contour (see below). From what I have seen, the stretch of shore just above and somewhat below low-water mark is essentially the home of this association. It usually grows on a rocky substratum and on *Laminaria* stems at no great depth.

Cystoclonium purpurascens grows socially in many places both on a rocky substratum and on *Gigartina*. Sometimes it occurs in such abundance as an epiphytic vegetation in the *Gigartina-Corallina*-belt, that it is the alga which characterizes the vegetation, and not until the plants are moved aside is it seen that they are attached to a living substratum. On *Cystoclonium* various epiphytes occur, for example, *Chantransia*, *Monostroma Grevillei* and others.

Rhodomela lycopodioides very frequently grows scattered, and then plays only an insignificant rôle in the vegetation; but *Rhodomeleta* of limited extent also occur, often in contact with the *Polysiphonia urceolata*-associations.

Ceramium rubrum, *C. acanthonotum* and *Callithamnion Arbuscula* really belong to this association. In many places these species grow fairly socially and *Ceramieta* of *C. rubrum* and *C. acanthonotum* and *Callithamnioneta* of limited extent occur both on rocky substrata and on one of *Gigartina*; however, I think that these species occur too sparsely to be termed association-formers.

Sphacelaria radicans also belongs to this association. Often, even at low-water mark, it covers flat stones with a dense vegetation, but though these small *Sphacelarieta* are considerably distributed, yet they cannot be called associations.

In the Færøes a similar *Polysiphonia urceolata*-vegetation occurs (Börgesen, 12, p. 731).

12. The Community of *Corallina*.

The members of this community are *Corallina officinalis*, *Gigartina mamillosa*, *Chondrus crispus* and *Ahnfeltia plicata*. These species occur as a rule in luxuriant and more or less sharply defined associations, which very frequently occur together, and may therefore be regarded as nearly related to each other.

The fronds are branched, and their consistency is on the whole firm because, as is known, *Corallina* is encrusted with calcium carbonate, *Ahnfeltia* is horny and *Gigartina* and *Chondrus* are cartilaginous.

Gigartina and *Corallina* generally occur in a belt at the limit of extreme low-water; in my diary I have always called this belt the *Gigartina-Corallina*-belt. *Gigartina*, however, extends higher up; on exposed coasts right up to the *Fucus*-belt, and even into that as under-vegetation; but, where *Gigartina* and *Corallina* meet, there is most frequently a mixed belt. These associations belong to S. and SW. Iceland.

The *Corallina*-association occurs most luxuriantly about low-water mark. The species grows extremely socially, and entirely covers depressions in the littoral zone which are more or less filled with water. The association occurs on somewhat exposed and also on very exposed coasts, but almost always in depressions surrounded by rocks upon which the waves break; yet I have seen it, where the exposure is but slight, covering the face of rocks below low-water mark. Only rarely have I obtained *Corallina* by dredging in greater depths, as, for example, on the north coast, at a depth of about 14 metres, where it seems to be present in abundance. It may be assumed with certainty, however, that this association has a much wider distribution below the limit of low-tide than is shown by the dredgings, and with exceptional low-tides it can be seen that in many places the *Corallina*-vegetation covers the rocks as far as the eye can reach.

On a very exposed coast I have met with *Corallina* growing socially in water-filled depressions at a considerable higher level, sometimes on a level with the upper part of the *Fucus*-belt. Here, however, with the exception of the lowest part of the frond, it is quite white in colour, and has evidently strayed outside its real domain. The spores have been carried to this height above the true *Corallina*-belt by the beat of the waves, and have been retained in the depressions. It can also thrive fairly well at this height during

the autumn and winter, both because the light is feeble, and because the increased high seas following stormy weather to some extent compensate for the difference in height. But it is in the spring and summer that it is most evident that *Corallina* has really extended too high up. According to Børgesen's description (12) it appears to extend still higher up in the Færøes.

In the *Corallina*-association an abundant epiphytic vegetation may occur, both of small algæ like *Chantransia* and of larger algæ such as *Monostroma Grevillei*, *Spongomorpha vernalis*, *Acrosiphonia albens* and also the *Leathesia*-associations. Furthermore, *Ceramium rubrum*, *Cystoclonium*, *Delesseria sinuosa* and *D. sanguinea* occur, and other red algæ, often in great quantities. When to this is added the fact that *Gigartina* is often abundantly intermingled with those already mentioned, it is easily seen that this mixed vegetation assumes quite a different character, according as to whether the brown-red *Gigartina* and *Ceramium* or the light-green *Monostroma* and *Spongomorpha* predominate. This characteristic appearance differs entirely from the usually monotonous appearance of the *Corallina*-belt. This epiphytic vegetation must be considered to form associations which do not really belong to the *Corallina*-vegetation in any other respect than that of having it for a substratum.

The *Gigartina*-association is widely distributed on very exposed coasts; it often is of very great breadth and, as already frequently mentioned, extends in under the *Fucaceæ* as undergrowth. Where the exposure is less, it does not reach so high; but yet, in the lower littoral zone there is, as a rule, a distinct *Gigartina*-belt, which most frequently occurs above the limit of low-tide. The *Gigartina*-vegetation extends also below the limit of low-tide, but it seems to belong most closely to the lower littoral zone. The belt is quite characteristic, and can often be seen from a distance, as the colour is in strong contrast to that of the *Fucaceæ*-community. The species is of very social growth and is usually dominant where it occurs; not rarely, however, a few species occur intermingled with it, especially in the Vestmannaeyjar and at Öndverðarnes, two very exposed localities. In the *Gigartina*-belt *Corallina* may occur lowest, *Callithamnion Arbuscula* is sometimes plentifully intermixed with the *Corallina* and occurs also in abundance as an epiphyte, and *Ceramium acanthonotum* occurs rather frequently and often abundantly. In the Vestmannaeyjar *Callithamnion scopulorum* occurs rather frequently as undergrowth. In addition, *Ceramium rubrum*,

Delesseria alata, *Acrosiphonia*, *Polysiphonia urceolata*, *Plumaria elegans* and *Rhodymenia palmata* occur. *Porphyra umbilicalis* occurs as an epiphyte in the Vestmannaeyjar, and also *Cystoclonium*, *Polysiphonia urceolata* and others.

The *Gigartina*-belt is very luxuriant in the Vestmannaeyjar and at Öndverðarnes; it may be said to be, on the whole, luxuriant in S. and SW. Iceland. As regards the relations between *Gigartina* and *Corallina*, the following observation from the Vestmannaeyjar may be recorded. At Brimsurð, on the south-east side of the inhabited island, where the littoral zone consisted of large, although not particularly high boulders, these were entirely covered above by a dense *Gigartina*-vegetation, while *Corallina* formed just as dense a belt around them below.

Chondrus crispus also grows socially in S. and SW. Iceland. It is true that *Chondreta* of lesser extent occur usually at or near low-water mark, but nowhere does the species occur nearly as luxuriantly as does *Gigartina*. The *Chondrus*-vegetation is most luxuriant in the Vestmannaeyjar and at Eyrarbakki. Between the skerries off the latter place, the broad-fronded form grew in abundance, both above and a little below the limit of low-tide. In both the places mentioned, which belong to S. Iceland, it grows in such abundance that the vegetation might almost be termed an association; in SW. Iceland on the other hand, it seems to occur more sparsely, and the small *Chondreta* may then be considered to belong to the *Gigartina*-association.

Ahnfeltietum. *Ahnfeltia plicata* grows socially in S. and SW. Iceland and usually forms a narrow belt at and below the limit of low-tide. The individuals are very frequently matted together by the byssal threads of various small molluscs, and worms and quantities of snails are found between the plants. In reality this vegetation is more nearly related to the *Corallina*-association than to the *Gigartina*-association. This species grows also scattered among *Corallina* and *Gigartina*.

The intermingled species are only few in number, for example, *Ralfsia deusta* which may occur abundantly in small depressions, and *Leathesia difformis* which sometimes occurs in abundance as an epiphyte. *Ahnfeltia* is most frequently decoloured above low-water mark.

Chætomorpha Melagonium occurs rather frequently, grow-

ing scattered in the *Corallina-Gigartina*-belt, without playing any further part in the vegetation.

The *Leathesia*-association is here mentioned in connection with the *Corallina-Gigartina*-belt. The brown, spherical, cartilaginous *Leathesia difformis* is found in abundance in this belt only, and I prefer to mention it here rather than to place it in the *Chorda*-association. The species occurs only as an epiphyte, not only on *Ahnfeltia* but also on *Corallina*, *Gigartina* and *Chondrus*, and is often wonderfully numerous. The size varies greatly, often the globules may be rather large and, by their yellowish colour greatly alter the appearance of the vegetation. It often almost entirely covers rather extensive *Corallineta*. The species is a summer-form, which does not occur in any quantity worthy of mention until the month of June, flourishes during July and August, and disappears in September, at any rate in SW. Iceland.

Small specimens of *Leathesia* occur also on *Rhodymenia palmata*.

13. The Crustaceous alga-association.

At low-water mark and in the lower littoral zone, there occurs a crustaceous algal vegetation which may be considered a direct continuation of the sublittoral crustaceous algal vegetation (see below, p. 148). Here, the species are, for the most part, the same, e. g. *Lithoderma fatiscens* and *Lithothamnion compactum*. Both these species often have a somewhat considerable distribution in the lower littoral zone. The *Hildenbrandia*-association mentioned as existing in the upper littoral zone also occurs here. *Lithothamnion læve* and *Phymatolithon polymorphum* also occur in the lower littoral zone. In addition, we have *Ralfsia deusta* which, in many places, forms patches upon the bottom of pools in the lower littoral zone, and plays rather an important rôle in the vegetation.

Tide-Pools of the Lower Littoral Zone are most frequently depressions which are either directly connected with the part which is constantly submerged or separated from it by a ridge; which may happen to be the case is unimportant as the period of exposure in this part of the littoral zone is extremely short, as is also seen from the fact that the vegetation in these depressions consists of sublittoral associations, or more correctly, of stragglers from them. Thus, *Laminaria* and *Alaria* species frequently occur in

these depressions which fact will be mentioned again later on. Some of the depressions are occupied by semi-littoral associations, thus, *Corallineta*, *Gigartineteta*, *Chondreta*, *Monostrometa*, *Ceramieta*, etc. frequently occur, and, in addition, several of the species which belong to these associations are found growing in a scattered manner.

As mentioned above (p. 125), the vegetation in the pools is highly heterogeneous, and, in the large pools it can frequently be seen that the associations or their representatives arrange themselves in belts, here on a small scale in the same manner as they do on a larger scale outside the pools.

c. The Sublittoral Zone.

The sublittoral vegetation covers the sea-bed from the limit of low-tide down to a depth of 40—60 metres, and perhaps to an even greater depth. Under normal circumstances it is not exposed during low-tide; yet it may happen that the uppermost *Laminariæ*, especially when small, become exposed during extreme low-water, but this must be considered exceptional. What especially characterizes this zone is the circumstance that the associations are always submerged. The associations are certainly few in number, but most of them have a remarkably wide horizontal distribution, and the vegetation, taken as a whole, is homogeneous. With the exception of illumination the conditions of life must be supposed to be stable; in any case, compared with the conditions of life in the littoral zone, they are unstable to a very slight degree. In the littoral zone the change of season is noticeable, but in the deep, under normal circumstances, these changes are very slight. The character of the vegetation is therefore nearly the same all the year round.

The *Laminariaceæ* vegetation, as previously mentioned, is dominant in this zone and stretches in a broad belt along the coasts. Beyond the *Laminaria*-belt another narrower belt occurs composed almost exclusively of *Rhodophyceæ*.

14. The Community of *Laminariaceæ*.

This community occurs especially on a rocky substratum, and extends over large areas of the sea-bed from about the limit of low-tide to a depth of about 30 metres. It forms a belt round the coasts, and varies in breadth according to the conditions of depth and the nature of the substratum. This belt is for the most part

continuous, although only as far as the substratum is favourable for its development. By reason of the nature of the substratum, both the upper and the lower boundaries often have an irregular course, and stragglers from the main body of the vegetation often occur. Those *Laminariaceæ* which occur in the low-lying tide-pools must be regarded as stragglers from the *Laminariaceæ*-community which exists below. In the same way there are stragglers which extend outwards into deep water, as some members of the community have been found at a depth of 40 metres. The community occurs both on exposed coasts and on those which are partly exposed, as well as on sheltered coasts. It is composed of perennial species with, as a rule, strongly developed organs of attachment, a stem-like stipe and, as a continuation of this, a lamina or leaf-like portion which is originally undivided, but in some of the species, is later divided by longitudinal slits into many lobes. The species are the largest of all the algal species in the northern seas: they grow both in pure associations and highly intermingled with one another. The community may be said to resemble a "forest" on the sea-bed; sometimes the "forest" is pure, sometimes mixed, and it has its undergrowth, its "stem" epiphytes and its "leaf" epiphytes.

The species which occur are *Saccorrhiza dermatodea*, *Laminaria*-species and *Alaria*-species. Like the *Fucaceæ*-community in the littoral zone, the *Laminariaceæ*-community is composed of a few species of very social growth, and, just as the *Fucaceæ*-community forms the greater part of the bulk of the vegetation in the littoral zone, so does the *Laminariaceæ*-community below the limit of low-tide. If the range of the associations differs in depth this will be mentioned when they are described.

The Associations of the *Laminariaceæ* Community occur in many places in fairly regular succession from the coast out towards the deep sea. Thus, often quite close to the coast, *Laminaria saccharina* or *Alaria esculenta* is found occurring in very great abundance in pure or mixed associations; beyond is found a belt of *Laminaria digitata*; and deepest of all *Laminaria hyperborea*. But the order is not always so regular, and at lesser depths it is frequently seen that the species occur socially on small areas of the substratum, sometimes one species being dominant and sometimes another. The species may also occur scattered amongst one another, especially at lower depths. There is a difference in the

character of the community in sheltered and in exposed places, which is evident from the description of the association given below. In sheltered places the calm-water character predominates; to this belong the *Saccorrhiza dermatodea*-association, the *Alaria Pylaii*-association, the *Laminaria færoënsis*-association and the calm-water associations of *L. saccharina* and *L. digitata*. Of the very much exposed associations, the only essential one to be recorded is the *Stenophylla*-association (see under *L. digitata*). In addition, a difference is evident according to the depth, and the associations then occur either with a shallow-water character or with a deep-water character (see below).

In its main features, this community occurs in a similar manner on the coasts of adjacent countries. The communities of S. and SW. Iceland greatly resemble those of the Færøes, as has been frequently mentioned, and also those of western Norway (Boye, 10; Hansteen, 25) and of Finmark (Foslie, 18).

The *Saccorrhiza dermatodea*-association. I have most frequently found this species just below the limit of low-tide, where it is of medium size, and grows scattered. In water-filled depressions in the lowest part of the littoral zone which, although they lie above the limit of low-tide, belong from a biological point of view to the lower-lying area, the species is often very social and forms pure associations. I have found it growing very socially at a greater depth (22—28 metres) within Reyðarfjörður in E. Iceland off Hólmanes or thereabouts; the specimens which occurred there were of large size. When the various *Ectocarpaceæ* which may occur on old individuals are excepted, the plants are usually free from epiphytes. The association develops best in somewhat sheltered places.

The *Alaria Pylaii*-association. *Alaria Pylaii*, as mentioned below, often grows interspersed amongst *Alaria esculenta* f. *pinnata*, *Laminaria saccharina* and others, in somewhat exposed places; but its real habitat is in the interior of the fjords, where the water is calm. Here occur the typical, large, broad-fronded individuals: they are often social in growth and then form pure or almost pure associations; but they are most frequently distributed in patches, and then alternate with *Saccorrhizeta* or social growths of *Laminaria nigripes* v. *atrofulva*. In such places occur also the broad-fronded calm-water forms of *Laminaria saccharina* and *L. digitata*. *Alaria*

Pylaii occurs thus as a calm-water form corresponding with the deep-water form of *Alaria esculenta* and with the form found on exposed coasts. I have found the *Alaria Pylaii*-association well developed in E. Iceland at a depth of 20 metres. The species also extends higher up and may, like all the other *Laminariaceæ*, occur at about the limit of low-tide or in the water-filled depressions in the lower littoral zone, but is then, like those *Laminariaceæ*, of small growth.

The *Laminaria færoënsis*-association. The species in question grows socially at a depth of 20—30 metres in Fossárvík at the head of Berufjörður in E. Iceland. In its external appearance this association exactly resembles the deep-water association of *Laminaria saccharina*. The structure of the stipe differs however, because *L. færoënsis* has a hollow stipe like *L. longicruris*: as Rosenvinge (63, p. 211) and Börgesen (12, p. 766) point out, the air-filled hollow space probably serves to lift the large lamina from the sea-bottom.

In deeper water, *L. færoënsis* occurs in the same manner in the Færøes as it does in E. Iceland (Börgesen, loc. cit., p. 766), but differs somewhat in shallow water. In Greenland and Iceland, as in the Færøes, the hollow-stemmed *Laminariæ* prefer protected localities.

The *Alaria esculenta*-association. This is distributed very commonly along all the coasts of Iceland. It prefers a rocky substratum, but may occur also on pebbles as *Laminaria saccharina* occurs, and frequently in company with it. As a rule, the association is best developed at a depth of 6—16 metres; but the species occurs, in addition, growing socially at a depth of 3—4 metres and again, sometimes as deep as 30 metres. The association is pure or only slightly mixed, and then usually with *L. saccharina*, *L. digitata* or *Al. Pylaii*; it often stretches for miles in the fjords. The species (*Alaria esculenta*) varies in a manner somewhat similar to the variations of *Laminaria saccharina* and *L. digitata*. In very exposed places, there is found in shallow water a narrower-fronded form with narrow, leathery sporophylls. This form cannot be termed a surf-form like *L. digitata f. stenophylla* but it may, however, merit the title of an exposure-form. Another form, which is much larger, both as regards the length and breadth of its fronds, occurs in deeper water

(*f. pinnata*). This alga is one of the largest found on the coasts of Iceland, and may at times attain a length of 6—8 metres. The form of the frond resembles to some extent the shallow-water form of *Laminaria saccharina*, the thick mid-rib of *Alaria* corresponding with the thickened median area of *Laminaria*. The fronds of both species are thus well adapted to withstand the motion of the waves; in fact both species are rather frequently found intermingled in a broad belt along the coasts. On many of the sunken skerries which are such a danger in navigation, *Alaria esculenta* is the principal species, indeed frequently growing alone. In Hvammsfjörður in SW. Iceland, in places where a strong current exists (Röstin) there was found a dense vegetation of broad-fronded *Alaria esculenta f. pinnata* with very long laminæ.

It is general knowledge that the lamina is torn in pieces by the waves, and cases are frequent also in which the thin part of the lamina is divided into many pieces by transverse slits, often nothing remaining save the mid-rib itself, especially in the upper part of the lamina. A luxuriant *Alarietum* was found below the limit of low-tide at the extreme point between Seyðisfjörður and Loðmundarfjörður; it consisted mainly of *Alaria esculenta f. pinnata* with *Alaria Pylaii* and *Lam. saccharina* intermingled. It was at once noticeable that the uppermost *Alariæ* were entirely frondless; the stipes were completely overgrown with *Ectocarpaceæ*. It must be admitted that the situation was exposed, and therefore it may well be that the laminæ were destroyed by the beat of the waves; but there is just as much reason to believe that this was occasioned by the drift-ice, which had made its appearance on the coasts some time before my arrival. In this locality the *Fucus*-belt had also been scraped off the rocks in several places which, in my opinion, was caused by the drift-ice.

The *Laminaria saccharina*-association. This association is very luxuriant, and occurs almost pure over stretches extending for miles along the coasts. It does not always grow on a firm, rocky substratum: rather frequently it occurs on a pebbly substratum, in which case the plants are attached either to a single pebble or to several, as if lying at anchor. With dredgings, therefore, it rather frequently happens also that the plants with their "anchors" are dragged up from the sea-bottom. This association is met with from a depth of about 2 metres, or from

about the limit of low-tide, down to a depth of about 30 metres. Small individuals may be found in the lowermost water-filled depressions of the littoral zone. Compared with the other commonly distributed *Laminaria*-species, *L. digitata* and *L. hyperborea*, then *L. saccharina* generally keeps nearest to the coast, especially the more leathery, shallow-water form. In shallow depths the succession can be perceived distinctly, but with regard to greater depths conclusions must be drawn from what is brought up by the dredge. The succession usually is, that while *L. saccharina* keeps nearest to the land *L. hyperborea* extends deepest.

As is well known the species varies very much, according to the depth and the degree of exposure. A form with leathery, thick fronds with a rough surface occurs near land on somewhat exposed coasts in those depths where the effect of the beat of the waves is distinctly observable. At greater depths another form occurs, the deep-water form, with long, broad and comparatively thin fronds; and in protected localities inside the fjords of E. and W. Iceland a third form occurs at a depth of 4—20 metres. This form (*f. latifolia*) is long-stemmed, with comparatively very broad lamina and an entirely smooth surface. As each of these forms grows very socially the character of the association varies in accordance with the depth and the exposure.

The *Laminaria digitata*-association. This association is very common everywhere along the coasts where there is a rocky substratum, from a depth of about 4 to about 25 metres. On rocky coasts, however, small specimens occur just at the limit of low-tide, and there represent a kind of boundary. Small individuals may occur also in water-filled depressions in the lowest part of the littoral zone.

The tendency of *Laminaria digitata* is to vary in the same manner as *L. saccharina*, and thus the character of the association differs according to the depth and the degree of exposure, as the forms, individually, grow socially. The typical appearance of the association is determined by the deep-water form, or the typical form, which seems to grow most luxuriantly at a depth of about 10—20 metres. Here the species attains its greatest length and, as a rule, the stipe is so strong that it is able to raise the much-divided lamina from the bottom.

Just as the forms are connected with one another by inter-

mediate forms, so are the various associations connected. If the deep-water character of the association is taken as a starting point, we notice that it changes gradually with decreasing depths on exposed coasts, and that somewhere near the limit of low-tide it assumes an entirely different character, which is displayed in the leathery, long-stemmed form with a narrow and slightly-divided frond (*f. stenophylla*). On an exposed coast this variety might be termed the shallow-water type or perhaps, rather, the surf-type, in conformity with the surf-form of *Fucus inflatus*. The surf-character was very beautifully and typically developed in the Vestmannaeyjar; here *f. stenophylla* grew very socially, forming a continuous belt, the upper boundary of which occurred almost at the limit of low-tide. When during low-tide the waves receded it was very interesting to see how easily the leathery, narrow, slightly-divided laminae moved with the waves, and everywhere, as far as the waves receded, the rocky substratum between the *Stenophylla*-individuals was quite reddish in colour from the encrusting *Phymatolithon polymorphum*. The *Laminaria* plants were very firmly attached to the rock — a fact evidently well known to the fishermen, as they fastened the boat to a *Laminaria* while we went ashore. The stipe is leathery and pliable, and the plants cling closely to the substratum when the waves recede.

I have found *f. stenophylla* in other places, although not in such abundance, and not quite so typical. Here the same rule applies as with regard to *Fucus inflatus* and *Laminaria saccharina*, that the tendency to vary seems to depend on the greater or lesser movement of the water; on coasts which are somewhat exposed, a *Laminaria digitata*-association is rather frequently found at about the limit of low-tide, with a character midway between the surf-character and the deep-water character.

If we again take the deep-water character of the association as a starting point, and move inwards towards the protected coasts, we see that the character changes again, but in another direction. The stipe becomes shorter and the frond much broader and slit into fewer and broader lobes. Within the fjords, in W. and E. Iceland especially, the character is entirely different from the deep-water character. Here occur forms with very broad fronds which are either undivided or divided into two, or a few, very broad lobes (*f. cucullata*). Generally the depth is about 4—20 metres, even deeper occasionally. I have found associations with this character

well developed in E. Iceland. At an insignificant depth, where I was able to see the sea-bottom, the individuals were not really closely placed, but lay on the bottom; some quite flat, and others slightly obliquely with the hollow surface turned upwards to the light. In this way the sea-bottom was almost entirely covered by the broad fronds.

This character might be termed the calm-water character, and an association-character exactly corresponding with it is found in *Laminaria saccharina* and *Fucus inflatus*.

Laminaria digitata f. *cucullata* occurs also scattered among *Laminaria nigripes* v. *atrofulva* and *Alaria Pylaii*.

The *Laminaria* hyperborea-association. It is developed luxuriantly in S. and SW. Iceland, and occurs also in E. Iceland and N. Iceland, in those places which I have visited. I can pronounce no opinion upon its general distribution in N. Iceland, as dredgings have been undertaken there in a few places only; yet I think that it occurs everywhere there. In E. Iceland, on the other hand, where I have done a great deal of dredging, I have only found it at the mouth of Berufjörður. It is very luxuriant in the Vestmannaeyjar, forming a continuous belt round the inhabited island.

The association grows on a rocky substratum, from a depth of about 4 metres to about 30 (or 40) metres, and occurs both on exposed and on slightly exposed coasts; close to the limit of low-tide and in water-filled depressions in the lowermost part of the littoral zone small specimens may occur. In shallow water, with exceptional low-tides, the upper part of the stipe is frequently seen rising above the surface, raising the lower part of the frond obliquely above the water. Börgesen (12, p. 755, Fig. 160) has reported and illustrated this from the Færøes.

In Iceland *L. hyperborea* does not vary in the same manner as do *L. saccharina* and *L. digitata*, the fact being that it does not occur in protected places, and on exposed coasts does not extend so far up as the two species mentioned. Those specimens which occur close to the limit of low-tide, or in pools in the littoral zone, are quite as typical as the large, deep-water individuals. The association seems to thrive best at a depth of about 20 to 30 metres, but on somewhat exposed coasts it also thrives fairly well at lesser depths, and is then very frequently mixed with the other members of the community; while at greater depths it is generally pure. As

is generally known, the species has very strong haptera, often arranged in rows, which issue from the lower part of the stipe, so that the haptera appear one above the other in vertical succession. They then look like a vertical row of obliquely placed props, one above the other; such rows issue in all directions from the stipe. By this it must be understood that, as the plant grows, new haptera appear, usually in the regular succession mentioned, until such time as the plant attains its normal size. The development of the haptera must necessarily keep pace with the rest of the growth, because the larger the plant becomes so much the more is it moved by the waves, and so much the stronger must the props become if the plant is not to be torn up. The youngest props are the longest, and are situated at the extreme (upper) end of the row. That the growth of the organs of attachment is contemporaneous with the increase in size of the individual applies also, of course, to the other *Laminariaceæ*, but scarcely anywhere is it seen so distinctly as in this species.

In its main features *L. hyperborea* behaves in Iceland — at any rate in S. and SW. Iceland — in the same manner as it is recorded by Børgesen (12, p. 755) to behave in the Færøes.

The Under-vegetation. No doubt an abundant under-vegetation occurs everywhere, chiefly formed of crustaceous algæ as a lower layer, and of branching or membranaceous *Rhodophyceæ* and a few *Phæophyceæ* in addition as an upper layer. Here, as in the *Fucus*-belt, it must be assumed that the under-vegetation is of no real value to the upper; while, on the other hand, the latter affords protection to the under-vegetation — in the *Fucus*-belt against desiccation and too strong light, and in the *Laminariaceæ*-community against strong movements of the water. The subdued light caused by the *Laminaria* fronds is, no doubt, also of importance in the upper portion of the *Laminaria*-belt, in so far, at any rate, that the species with a more downward range may endeavour to attain greater heights. In the lower portion of the *Laminaria*-belt the subdued light does not seem to affect the under-vegetation very much which seems to thrive there just as well as in open places where *Laminariaceæ* are absent; to have the waves moderated may be beneficial to the under-vegetation, especially in shallow water. During excessive ebb-tides opportunities may occur in many places of seeing how the *Laminaria* fronds moderate the motion of the waves, that is when this is not too violent, as, for example, when it approxi-

mates to surf. In deep water the *Laminaria* fronds will always moderate the motion.

In shallow water, especially where the bottom can be seen, it is easy to observe the under-vegetation, but in deep water one has to rely upon the specimens brought up by the dredge.

The under-vegetation is not divided according to the various associations of the upper vegetation, but seems to possess the same character wherever it is observed. In S. Iceland (the Vestmannaeyjar and Eyrarbakki) *Phymatolithon polymorphum* occurs in great abundance, covering the bottom entirely for large distances near the coast as an undergrowth. It is mainly composed of crustaceous, membranaceous, and more or less branching *Florideæ*.

A. Crustaceous Algæ. In several places in N. and E. Iceland I found a luxuriant under-vegetation formed of *Lithothamnion læve*, *L. circumscriptum* and *L. glaciale*. Among these species the first mentioned especially seemed to be widely distributed both on the bottom of an *Alaria* and a *Laminaria* association. In E. Iceland *Lithothamnion flavescens* and *L. foecundum* in addition, like *Clathromorphum compactum*, were very frequent on a *Laminaria*-association-bottom. Together with these species occurred *Peyssonellia Rosenvingii*, *Cruoria arctica*, *Lithoderma* and others, as in the crustaceous algal vegetation (see p. 155).

B. Membranaceous and Branching filamentous species. The upper layer, with which are also associated intermingled species, varies considerably according to the depth. In addition to a number of the species which extend further downwards, various semi-littoral species may thus occur in the upper part of the *Laminaria*-belt. A number of the species which grow on the *Laminaria* stems may also occur on the bottom between the *Laminariæ*.

Here it is really a question of several associations; the lowest layer, as mentioned, is the crustaceous alga-association; the second layer is composed in its upper part of semi-littoral associations, which meet the associations which extend deeper and are mainly associations of *Rhodophyceæ*; and the uppermost layer is the *Laminaria*-association. The species are named where these associations are mentioned, and are therefore omitted here.

The Epiphyte-vegetation. Epiphytes very frequently occur on the stipes and laminæ of the *Laminariaceæ*, and it is a particularly common occurrence for old stems of *Laminaria hyperborea* to be entirely overgrown, for the epiphytic vegetation is much more

luxuriant on this species than on the remaining *Laminariaceæ*. It happens rather frequently, however, that a rich epiphytic vegetation occurs on *L. digitata*, *L. saccharina*, *Alaria esculenta* and *Saccorrhiza dermatodea*. The epiphytes generally occur most abundantly on the older individuals. The vegetation on the stems is usually composed of species which may be found growing among the *Laminariæ*, and then belong to the second layer of the under-vegetation, which can thus be raised upon the *Laminaria* stems; consequently, it is very natural that the composition of the species of the epiphytic vegetation should vary according to the depth. The following distinction is evident: that the semi-littoral species which grow epiphytically in shallow water vanish as the depth increases; while, on the other hand, some of the deep-water species may occur at a relatively lesser depth.

The following species have been found to occur on stems of *Laminariaceæ*, and may almost all be found on *Laminaria hyperborea*: —

Ahnfeltia plicata.	Rhododermis parasitica.
Antithamnion floccosum.	Rhodophyllis dichotoma.
A. Plumula v. boreale.	Rhodymenia palmata.
Ceramium rubrum.	Desmarestia aculeata.
Delesseria alata.	D. viridis.
D. sanguinea.	Ectocarpus confervoides.
D. sinuosa.	E. fasciculatus.
Dermatolithon macrocarpum.	E. Hinksia.
Euthora cristata.	E. penicilliformis.
Gigartina mamillosa.	E. siliculosus.
Lithophyllum Crouani.	E. tomentosoides.
Lithothamnion circumscriptum.	Isthmoplea sphærophora.
Lomentaria clavellosa.	Laminaria digitata.
L. rosea.	L. hyperborea.
Odonthalia dentata.	Leptonema fasciculatum.
Petrocelis Henedyi.	Litosiphon filiformis.
Peyssonellia Rosenvingii.	Sphacelaria olivacea.
Plocamium coccineum.	S. radicans.
Polysiphonia arctica.	Monostroma fuscum.
P. parasitica.	M. Grevillei.
P. urceolata.	M. undulatum.
Porphyra miniata.	Ulothrix flacca.
Ptilota pectinata.	Ulva Lactuca.
P. plumosa.	Ulvella fucicola.
Rhodochorton repens.	Urospora Wormskioldii.
R. Rothii.	51 species in all.

In addition, the fungus *Dothidella Laminariæ* must be mentioned; it is a very common endophyte in the stipe of various

Laminariaceæ. It occurs most commonly at depths of from 6—20 metres, but has also been found as deep as 30 metres.

Many of these species grow very socially and often cover the stipes completely, or nearly so. At Reykjavík, it is very usual in the spring to find *Laminaria hyperborea* in shallow water (4—10 metres) with the stipes entirely overgrown by *Rhodochorton Rothii*, *Antithamnion floccosum* and *Polysiphonia urceolata*, each on its own particular stipe, or else intermingled. *Petrocelis* and *Rhododermis* occur also in great abundance, almost covering entire stipes. In the Vestmannaeyjar and at Eyrarbakki it was also a fairly common occurrence to find stipes of *Laminaria hyperborea* completely overgrown by *Dermatolithon macrocarpum*. In the northern part of the country *Lithophyllum Crouani* also sometimes covers the stipe of *L. hyperborea* over its entire length. Many of the remaining species may also occur abundantly, but most frequently the vegetation upon the stipes is mixed, and crustaceous species grow side by side with branching and membranaceous species.

The epiphytic vegetation seems to be most luxuriant and richest in species at lesser depths, where the semi-littoral associations meet the associations which extend deeper down, and where, in addition to the *Rhodophyceæ* which always predominate, both brown and green species occur. At a greater depth the species are few, and are almost exclusively *Rhodophyceæ*. Generally, the rule seems to hold good that while the species with a more downward range occur on the haptera or on the lower part of the stipe, the more light-loving species occur on the upper part of the stipe; the green algæ, however, are by no means always uppermost. Thus in the upper portion of the *Laminaria*-belt *Euthora*, *Rhodophyllis*, *Odonthalia* and others frequently occur among the haptera, but in the lower portion of the belt they may be found on the stipe almost everywhere, especially *Euthora*. This agrees with Berthold's observation of the succession of epiphytes on *Cystosira* in the Mediterranean, and with Børgesen's observation of the order of the epiphytes on *Laminaria hyperborea* in the Færøes.

The vegetation on the stipe of *L. hyperborea* is extremely luxuriant in S. and SW. Iceland and is considerable both in NW. and N. Iceland, but is poor in E. Iceland.

Epiphytes frequently occur also on the fronds of the *Laminariaceæ*, especially in the upper portion of the *Laminaria*-belt. Here the brown algæ predominate, while only a few red and green

algæ occur. The following species are common or, at least, occur very socially: —

Chantransia Alariæ.	Myrionema Corunnæ.
Rhodochorton membranaceum.	Phæostroma pustulosum.
R. penicilliformis.	Pylaiella litoralis.
Ascocyclus islandicus.	Streblonema Stilophoræ.
Ectocarpus tomentosoides.	Acrosiphonia incurva.
Litosiphon filiformis.	Ulothrix flacca.

All the remaining *Ectocarpus*-species which are found on the stipes occur in addition. Of the species mentioned there are three in particular which grow very socially: *Chantransia Alariæ* covers the entire frond of *Alaria esculenta* from tip to base; *Ectocarpus tomentosoides* also grows very socially on the fronds of *Laminaria hyperborea* and *L. digitata* which it frequently, entirely or nearly, covers during spring-time, at which time, also, *Litosiphon filiformis* often covers large portions of the lamina of *L. saccharina*.

Myrionema Laminariæ and *Streblonema æcidioïdes*, in addition, grow as endophytes in the *Laminaria* fronds.

Thus, at least 62 species of marine algæ, or about 59 % of the algal species (113) which grow below the limit of low-tide, occur on or in *Laminariaceæ*.

On other coasts, those of the Færøes, for example (Börgesen, 11 and 12), and those of Norway (Boye, 10) a similar epiphytic vegetation occurs in the *Laminaria*-association. On the coasts of Greenland (Rosenvinge, 63) the epiphytic vegetation is much scarcer in the *Laminaria*-belt, which is possibly due, in part, to the absence of *Laminaria hyperborea* from that country.

15. The *Desmarestia*-association.

Desmarestia aculeata is very common and grows both scattered and socially; vertically it is widely distributed, as it has been found at depths of from 4—60 metres (in E. Iceland). It seems to grow most luxuriantly at a depth of about 6—30 metres, and then is frequently found in associations of lesser extent. Only rarely is this association found dominant on the bottom, and even then only in small patches. Most frequently it occurs intermingled with other associations; thus, when dredging on a *Laminaria* bottom, it very frequently happens that *Desmarestia aculeata* is brought up, and as frequently as not it is intermingled with the associations which extend deeper down. It often grows among the *Laminariæ*.

where there are openings in the *Laminaria*-vegetation, and beyond the *Laminaria*-belt it is very frequently found on a sandy or pebbly substratum, at any rate at inconsiderable depths. In the *Laminaria*-belt proper it plays the rôle of a kind of "underwood," but beyond the belt, at greater depths, it protrudes far above the associations of red algæ.

Desmarestia viridis occurs in a similar manner, very often with the other species, both inside and outside the *Laminaria*-belt. It is of less importance, however, as it is much less common. At depths of between 20—30 metres it may also occur dominantly in patches.

In E. Iceland, at a depth of 20—30 metres, *Chorda tomentosa* occurs growing very socially with the *Desmarestia* species.

Of the epiphytes on *Desmarestia aculeata* the small *Porphyropsis coccinea* is of most importance (in S. and SW. Iceland).

In several respects this association recalls the semi-littoral *Chorda*-association.

Similar *Desmarestia*-vegetation occurs in the Færøes (Börge-sen, 14), in Greenland (Rosenvinge, 63) and in northern Norway (Foslie, 18, p. 100).

16. The Deep-water Community of Florideæ.

A mixed society, which consists mainly of a few species of red algæ, generally occurs at a depth of about 15—40 metres (over 50 metres in E. Iceland). To judge from the dredgings, the plants sometimes seem to grow socially — at any rate over small areas — and sometimes to grow scattered, then, as a rule, much intermingled with one another.

The species which seem to have an abundant local distribution in fairly many places are the following: *Delesseria sinuosa* at depths of from 14 to nearly 40 metres and somewhat deeper in E. Iceland; *Ptilota plumosa* from 16 metres to about 40 metres; *Odonthalia dentata* from 15—30 metres, and *Polysiphonia arctica* from 16—40 metres (10 to about 60 metres in E. Iceland). Thus each of these species forms associations, but these are often of inferior extent, with the exception, however, of that formed by the last mentioned species.

The *Polysiphonia arctica*-association. *Polysiphonia arctica* is of extremely social growth in E. Iceland, in Seyðisfjörður and in Reyðarfjörður. It grows most luxuriantly at depths of from 16—40 metres and forms an enormous, continuous belt along large

stretches of the coast. It is the only species of this community which forms a large, continuous and almost pure association, at any rate over considerable areas. The upper part of the association is, however, generally mixed with *Delesseria sinuosa*, *Ptilota*, *Odon-thalia*, *Rhodophyllis* and others, and then these species often occur in such abundance that the community acquires its usual mixed character; that is, several species occur dominantly side by side, though no single species can be said to predominate.

Among the remaining species of the community *Rhodophyllis dichotoma* is often rather social. It is very common for *Euthora cristata* to occur intermingled, but to judge from the dredgings it seems to have a scattered growth. *Ptilota pectinata* may be of fairly social growth in E. Iceland. *Delesseria sanguinea* and *Polysiphonia urceolata* occur also in this community, the first mentioned appearing to be most frequent while, in a few places, the latter has been found in abundance.

Of the species with a scattered growth which belong to this community may be mentioned: *Lomentaria clavellosa* (20—40 metres), *L. rosea* (20—40) and *Plocamium coccineum* (20 metres), all in the Vestmannaeyjar; and also *Turnerella Pennyi* and *Omphalophyllum ulvaceum* in E. Iceland.

In many places the under-vegetation of the community is formed of crustaceous species of *Lithothamnion*.

Of the intermixed species, *Desmarestia aculeata* and *D. viridis* are very frequent. In E. Iceland *Chorda tomentosa* has been found intermingled in this community. In addition, *Laminariaceæ* of scattered growth such as *Laminaria hyperborea*, *L. digitata*, *L. saccharina*, *Alaria esculenta*, *f. pinnata* and *Alaria Pylaii* occur very frequently; they are the outposts of the *Laminariaceæ*-community.

It has been previously mentioned that many of the members of this community grow on *Laminaria* stems, and that in several places the community forms, together with species of *Desmarestia*, the second layer of the under-vegetation of the community of *Laminariaceæ*.

The community grows both on somewhat exposed and also on exposed coasts, and occurs both on a rocky and on a pebbly substratum, and even on sand.

The semi-littoral *Polysiphonia urceolata*-association has much in common with this community.

Rosenvinge (63) and, following him, Børgesen (12) call this

community or quite similar communities: the sublittoral *Florideae*-formation.

17. The *Lithothamnion*-association.

In this association I include only the highly branched species, *Lithothamnion Unger*i and *L. tophiforme*, as these differ from the other calcareous algal vegetations by their characteristic and very social growth. Within the fjords, at a depth of about 12—25 metres, these algæ occur in such abundance that there might be good reasons for calling it a submarine reef of calcareous algæ. Within Arnarfjörður in the vicinity of Bildudalur there was, for instance, such a luxuriant vegetation of *L. Unger*i that the dredging-bag was filled time after time, nothing being found in it save this species. Mr. B. Sæmundsson has also found a similar *Lithothamnion* vegetation in several of the small fjords at Isafjarðardjúp; and as, moreover, there are specimens to hand from several other fjords in NW. Iceland, this association seems to be luxuriantly and commonly distributed in this part of the country. A similar vegetation, mainly composed of *L. tophiforme*, occurred also in abundance in Eyjafjörður in N. Iceland. I have also noticed a similar vegetation — though not so luxuriant — in several of the fjords of E. Iceland. Hörring collected *L. tophiforme* in Hvalfjörður in SW. Iceland, and Sæmundsson also found it there, apparently growing very socially.

In this association very few epiphytes occur, though *Turnerella Penny*i ought to be mentioned in N. and E. Iceland; on the other hand animals generally occur in abundance, especially *Ophiurida* and snails and other smaller molluscs which project everywhere from between the *Lithothamnion*-branches.

When dredging on such a bottom rather large pieces are hauled up, which cohere, usually, by reason of the numerous branches being matted together. Rather large globular masses, which are sometimes hollow, but which are often filled with comparatively thick interwoven branches, are also frequently obtained. The hollow masses must be supposed to have grown on the outer side of some substratum which has disappeared. This *Ægagropila*-form is generally known. Rosenvinge mentions it from Greenland, and assumes that it lies loose upon the bottom; the masses must then be illuminated all round by being rolled about as, for instance, by the action of the undercurrent. From what I have seen, it seems to me that a point of attachment can be perceived on entirely fresh

forms of *Ægagropila*, and in my opinion they are outgrowths upon old "blocks" of calcareous algæ. The action of the current probably loosens them, and they then roll about on the bottom. Undoubtedly they can live fairly long in that condition, but if they roll about much, they will surely by degrees go to pieces.

This association recalls the semi-littoral *Corallina*-community, particularly the *Corallina*-association.

The *Lithothamnion*-association occurs in Greenland (Rosenvinge, 63) but not at the Færøes (Börgesen, 12).

18. The Community of Crustaceous Algæ.

The characteristic life-form of the crustaceous algæ which is so essentially different from that of the rest of the marine algæ seems to justify the idea that they all belong to one community. With all of them the thallus is flat and, like the crustaceous lichens on the rocks, adheres by the whole of its lower surface to the substratum. As the form and the manner of development of the thallus in the different species are identical in their main features, I think that the community may appropriately be named after the crustaceous growth.

The substratum of the community consists of rocks, pebbles, mussel-shells and the like; also of other algæ, especially species of *Laminaria*.

The community has a very large distribution both in a horizontal and in a vertical direction, and possibly it is more particularly members of this community which we may expect to find in the vicinity of the absolute depth-limit of growth of algal vegetation. The community has already been mentioned as the under-vegetation in the *Laminariaceæ*-community; it occurs also as an undergrowth in communities which extend to a greater depth and thus, partly as a dominant growth on the bottom and partly as undergrowth, it reaches from the great depths right up to the limit of low-tide. The semi-littoral and the littoral crustaceous alga-associations should also be regarded as part of this community although, for practical reasons, they have been dealt with earlier in this paper. The community is pure, that is to say it is composed of only crustaceous algæ; there occur, it is true, various intermingled species, of which the majority are *Florideæ*, though some are *Phæophyceæ*, but these I consider unessential and almost irrelevant to the crustaceous alga-community proper. They have their homes in other communities,

and sometimes, perhaps, are in the act of forming an upper vegetation: sometimes they may be individuals which have "strayed" beyond the real limits of their community.

The community is divided into various associations, according as to whether the one or the other of the species is dominant over considerable areas. A widely distributed and typical *Phymatolithon-polymorphum*-association occurs, thus, in S. Iceland, and *Lithothamnion Lenormandi* has a fairly social growth at Reykjavík. *L. leve* and *Clathromorphum compactum* also form associations in several places. Judging from the dredgings, *Lithothamnion flavescens* and *L. foecundum* have a more scattered growth while, on the other hand, *L. glaciale* often occurs abundantly. Otherwise, it is very common for the *Lithothamnion* species to grow intermingled with, and at times upon, one another. The crustaceous, calcareous algæ form the greater part of this community in Iceland. The remaining crustaceous species, such as *Peyssonellia*, *Cruoria arctica* and *Lithoderma fatiscens*, are found more scattered, although the last-named species forms associations in shallow water right up to the limit of low-tide. These species must, however, be much more common on the sea-bottom than is shown by the dredgings. It may be taken for granted, also, that *Petrocelis Hennedyi* and *Rhododermis parasitica* occur on a stony substratum in deeper water, seeing that they are so common on the stems of *Laminaria hyperborea* at considerable depths. Both *Hildenbrandia* and *Petrocelis* occur on a stony substratum at shallower depths, and also *Ralfsia ovata*.

The species which has, with absolute certainty, been found growing deepest is *Lithothamnion leve* (see Part V), and it occurs in masses at a depth of 88 metres, that is, it forms a *Lithothamnionetum* at this depth. Thus, of all the marine algal communities in Iceland, this community extends deepest.

A similar vegetation occurs in Greenland (Rosenvinge, 63, p. 223), and in other places in the Arctic Sea (Kjellman, 36), but in both these places it differs in the wider distribution and greater luxuriancy of the *Lithoderma fatiscens*-association. In the Færøes (Börgesen, 12) the conditions seem to be somewhat similar, similar in any case to the conditions in S. and SW. Iceland, although *Lithoderma fatiscens* seems to occur there more sparsely than in Iceland.

B. The Sea-grass Vegetation.

The *Zostera*-association.

This association differs so much from the other marine communities in Iceland — the marine algal communities — that it must be regarded as not being in any way connected with them. The present community occurs especially on a substratum of muddy clay, which the algæ avoid. The “roots” of the algæ — the haptera — are organs of attachment only, their sole function being, in most cases, to attach the plant to the substratum — the stony substratum —, while *Zostera* has true roots which obtain nourishment from the substratum. For this reason *Zostera* requires a good nutrient substratum which is generally soft. It is rare, indeed it must be reckoned exceptional, for *Zostera* to be found growing on a hard clay-substratum. I understand such cases to indicate that formerly the substratum had been softer and then became more compact owing to the deposition of clay and sand, and that the *Zostera* is consequently about to disappear from such a spot. In places where there is no danger of either sand or clay being deposited from brooks or rivers the substratum will, nevertheless, scarcely remain unchanged, as the mud and ooze which are thrown down everywhere in the ocean, when once they have been brought to a place, readily accumulate and remain, in the shelter of the dense vegetation.

The *Zostera*-vegetation occurs widely distributed, especially in SW. Iceland where, in many places, both inside the smaller arms of the fjords and in the large fjords such as Breiðfjörður, a substratum of muddy clay occurs between the coast and the skerries which lie nearest. At Breiðfjörður, during low-tide, the pale-green *Zostera*-belt may be observed stretching for miles along the coast. At Faxaflói also the *Zostera*-vegetation has an extensive distribution. *Zostera* is found, most certainly, on other parts of the coast of Iceland, but nowhere have I seen such extensive “meadows” of it as in SW. Iceland.

The vegetation is generally pure and there is hardly an association of species in the sea off these coasts which is less mixed than the *Zostera*-association. In other places *Zostera* is a favourite substratum for epiphytes, but however much I searched I did not find anything worth mentioning on the *Zostera* plants here; in this respect the *Zostera*-meadow of Iceland agrees with that of the Færøes. At times, species belonging to the semi-littoral commu-

nities occur intermingled in the *Zostera*-belt; these then grow in small depressions, where the subsoil, usually a solid, clayey and pebbly substratum, appears. Such species are: *Chorda Filum*, *Chordaria flagelliformis*, *Castagnea virescens*, *Dictyosiphon foeniculaceus*, *Pylaiella littoralis*, *Ceramium rubrum*, *Cystoclonium purpurascens* and others. They should not be classed in the *Zostera*-association, and are mentioned only to explain the appearance of the *Zostera*-meadow.

The *Zostera*-association is sublittoral, but hardly extends as far down as do the semi-littoral communities. It cannot endure protracted exposure, and thus a substratum which would adapt itself well to *Zostera* may be found completely devoid of plants in places which are exposed for a long time during low-tide. From time to time, during extreme ebb-tides, the upper part of the *Zostera*-meadow may, however, be seen quite dry. But here two points have to be taken into consideration: the first being that the period of exposure is extremely short, and the second being that the extreme ebb-tides occur so seldom that they ought not to be taken into calculation. As a rule, the *Zostera* substratum is always submerged during low-tide. The water is so low, however, that the leaves float on the surface of the water, giving it a greenish tinge. When wading in a *Zostera*-meadow during low-tide the water reaches to about the knees.

In SW. Iceland the time of fruiting is during August—October.

On *Zostera*-soil there is in most places a very rich animal-life, but whether this has any influence upon the vegetation or on the nutrient substratum needs further investigation.

In connection with the *Zostera*-association I will just mention the Brackish-water-vegetation. It is so little known that there is nothing to be said about it, except that I have found *Ruppia maritima* in one solitary spot, where it grew so luxuriantly that, although scattered, it characterized the bottom.

VII. DIFFERENCES IN THE VEGETATION IN EAST AND SOUTH ICELAND.

East Iceland and South Iceland — at the south-eastern corner of the island, at about the stretch of coast from Vestrahorn to Eystrahorn — are divided by a rather sharp boundary both as regards the hydrography and the composition of the vegetation, as has been mentioned above. On the other hand, E. Iceland is connected with S. Iceland by a large transitional area (see p. 67) which stretches further along the north and north-west coasts and a part of SW. Iceland. The difference as regards the vegetation is therefore greatest between E. Iceland and S. Iceland; so it is these coastal districts which will exclusively or almost exclusively be treated of in this part of the present paper.

Where a great floristic difference exists between the different parts of the coast as, for instance, between E. Iceland and S. Iceland¹ (see Part III) it is to be expected that there will be differences in the vegetation, more especially as some of the species which are not common to all the coastal districts grow socially and form associations. The majority of the communities and the associations are however common to all the districts and are somewhat similar in appearance, as is also seen from the above description (Part VI), where the differences are always mentioned.

As regards the communities and associations common to both districts it is enough to refer to the above description. Here, only those communities and associations will be mentioned which are found in the one district but are absent from the other.

¹ The greater part of the coast of S. Iceland is a sandy coast or a barren "desert;" in this part of the present paper, by S. Iceland is meant only that part of the coast where vegetation occurs — the Vestmannaeyjar and the stretch of coast from Reykjanes in the direction of Thjorsa or somewhat more to the east than Stokkseyri.

Occurring in E. Iceland
and absent from S. Iceland.
Arctic Associations.
The *Monostroma groenlandicum*-
association.
The *Polysiphonia arctica*-associa-
tion.
Subarctic Association.
The *Laminaria feröensis*-associa-
tion.

Occurring in S. Iceland
and absent from E. Iceland.
Boreal Communities and Asso-
ciations.
The *Pelvetia-Fucus-spiralis*-belt.
The Community of *Corallina*.
The *Fucus serratus*-association.
The *Phymatolithon-polymorphum*-
association.

Further it should be pointed out that the epiphytic vegetation on *Laminaria hyperborea* is quite infinitesimal in E. Iceland, but very luxuriant in S. Iceland.

Of E. Iceland species which are important to the vegetation, *Laminaria nigripes*, *Turnerella Pennyi* and others are absent from S. Iceland. Of S. Iceland species which play a prominent part in the vegetation a great many are wanting in E. Iceland (see Part III).

The *Zostera*-association requires to be described separately. It belongs properly to SW. Iceland. *Zostera* is also known to occur in E. Iceland and it is possible that it forms associations there, but they are probably far more limited in extent than those in SW. Iceland. *Zostera* has not been found in S. Iceland itself, which is probably due to the fact that a favourable substratum for it is wanting there.

If we now leave the *Zostera*-association out of consideration, as the latter does not occur in S. Iceland, and confine our attention to the above-mentioned communities and associations which are found in the one district but are absent from the other, then it is seen that at any rate some of them characterize the vegetation to a considerable extent.

The *Monostroma groenlandicum*-association, as already mentioned, is peculiar to E. Iceland and has a considerable extension in several places there. It is not found in S. Iceland. *Monostroma groenlandicum* occurs sparingly both in N. Iceland and NW. Iceland, therefore it is possible that this association is not exclusively confined to E. Iceland. As the community of filiform algæ is commonly distributed both in E. and S. Iceland and green filiform algæ occur very luxuriantly in S. Iceland, the absence of *M. groenlandicum* from the latter place is of no essential importance to the vegetation as regards appearance.

The *Polysiphonia arctica*-association is of importance as regards the appearance of the sublittoral vegetation in E. Iceland. This association does not occur in S. Iceland, but a corresponding one occurs, which is however far less luxuriant, composed of *Polysiphonia urceolata*.

The *Laminaria færoënsis*-association is known to occur only in E. Iceland. This association is probably more widely distributed along Iceland than is at present known; the species occurs at any rate in N. Iceland. But I think that this species will hardly be found along the coast of S. Iceland owing to the fact that sheltered localities are wanting there.

The *Pelvetia-Fucus-spiralis*-belt is most commonly distributed in S. and SW. Iceland, and composes there the upper part of the *Fucaceæ*-community. As this belt is absent from E. Iceland there is a considerable difference in the appearance of the uppermost part of the *Fucaceæ*-community in the coastal districts in question. *Fucus spiralis* is, however, found in E. Iceland.

The Community of *Corallina* is also peculiar to S. and SW. Iceland and absent from E. Iceland. This community, or the *Corallina-Gigartina* belt, is very luxuriant and often of considerable extent in S. Iceland (and SW. Iceland), owing to which the semi-littoral vegetation in E. Iceland and in S. Iceland differs highly in character.

The *Fucus serratus*-association is poorly represented in S. Iceland, but it is luxuriant in a single locality in SW. Iceland. As *Fucus serratus* is rare, and somewhat resembles in appearance the large, broad-leaved forms of *Fucus inflatus* which are common everywhere, it plays only an inconsiderable part as regards the appearance of the *Fucaceæ*-community.

The *Phymatolithon polymorphum*-association is peculiar to S. Iceland, but as other crustaceous, calcareous algæ occur in E. Iceland in a similar manner though less luxuriantly, the absence of *Phymatolithon polymorphum* is of no essential importance as regards the appearance of the crustaceous-alga-vegetation.

From what has been stated above it is evident that the occurrence of the *Pelvetia-Fucus-spiralis*-belt and the *Corallina-Gigartina*-belt in S. Iceland (and SW. Iceland) gives to the littoral and semi-littoral vegetation of the southern district a character different from that of E. Iceland.

If we now turn to the individual species which (besides those already mentioned) are found in the one coastal district but are absent from the other, and which are important as regards the appearance of the vegetation, we see, as already mentioned, that such species are few in E. Iceland and numerous in S. Iceland. Some of these species have a fairly social growth without, however, forming independent associations. In the following, only those species are given which occur most abundantly.

East Iceland.	South Iceland.
Lithothamnion flavescens.	Lomentaria clavellosa.
L. foecundum.	Plocamium coccineum.
Laminaria nigripes.	Chantransia Alariæ.
Turnerella Pennyi.	Callithamnion Arbuscula.
Ptilota pectinata.	Plumaria elegans.
Peyssonellia Rosenvingii.	Ceramium acanthonotum.
Coilodesme bulligera.	C. rubrum.
Ulothrix consociata var. islandica.	Polysiphonia fastigiata.
	Rhododermis parasitica.
	Cystoclonium purpurascens.
	Ptilota plumosa.
	Petrocelis Hennedyi.
	Ectocarpus fasciculatus.
	E. tomentosus.
	Cladophora rupestris.
	Enteromorpha Linza.

It should moreover be noted that all the *Ceramium*-species are absent from E. Iceland. In S. Iceland, besides those mentioned above, *Ceramium atlanticum* occurs, and it will no doubt be possible to find several more *Ceramium*-species in S. Iceland.

The Epiphytic Vegetation on *Laminaria hyperborea*, as mentioned several times, is very luxuriant in S. and SW. Iceland; in NW. and N. Iceland it must also be said to be fairly luxuriant, but in E. Iceland it is quite infinitesimal in amount, which is probably connected with the fact that *Laminaria hyperborea* is rare in E. Iceland.

The epiphytic vegetation on the stipes of *Laminaria hyperborea* is very luxuriant and finely developed in S. Iceland. The following from the Vestmannaeyjar are given as an example: — dominantly on the stipe of *L. hyperborea* occurred *Rhodymenia palmata*, *Delesseria alata* and *Plocamium coccineum*; less abundantly than the three above-mentioned species occurred *Delesseria sanguinea*, *Lomentaria clavellosa*, *Lomentaria rosea*, *Euthora cristata*, *Gigartina mamilliosa*, *Ahnfeltia plicata*, *Petrocelis Hennedyi*, *Dermatolithon macrocarpum* and

Pterosiphonia parasitica. To show how rich in species the epiphytic vegetation occurring on a single individual of *L. hyperborea* may be, the following species, also from the Vestmannaeyjar, may serve: *Desmarestia viridis*, *Ptilota plumosa*, *Delesseria sinuosa*, *Delesseria alata*, *Lomentaria clavellosa*, *Polysiphonia urceolata*, *Plocamium coccineum*, *Delesseria sanguinea* and *Euthora cristata*.

So luxuriant and finely developed an epiphytic vegetation gives to the *Laminariaceæ*-community of S. Iceland a character different from that which it has in E. Iceland.

On the stipes of *Alaria* and *Laminaria digitata*, on the other hand, a similar epiphytic vegetation occurs in both the coastal districts.

The zonal division of the marine algal vegetation is in its main features similar in E. Iceland and S. Iceland, as is shown by the following examples which have been taken straight from the diaries.

East Iceland.

- | | |
|---|--|
| Vattarnes, steep cliffs,
highly exposed. ¹⁴ / ₇ . | VIII. Halosaccionetum <i>H. ramentacei</i> . |
| I. Ulothricetum <i>U. flacca</i> . | Urospora Wormskioldii. |
| II. Bangietum <i>B. fuscopurpureae</i> . | Polysiphonia urceolata. |
| III. Porphyretum <i>P. umbilicalis</i> . | Rhodomela lycopodioides. |
| IV. Fucetum <i>F. inflati</i> , in the most
exposed localities, consisting
only of <i>f. exposita</i> . | Chorda tomentosa. |
| V. Rhodymenietum. | IX. Alarietum. |
| Halosaccionetum. | Hólmanes, somewhat exposed,
sloping rocky coast. ¹⁸ / ₇ . |
| Acrosiphonietum. | I. Ulothricetum <i>U. flacca</i> . |
| VI. Sublit. Alarietum. | II. Enteromorphetum <i>E. intestinalis</i> . |
| Borgarnes, sloping rocky coast,
considerably exposed. ¹³ / ₆ . | III. Fucetum, uppermost, narrow
margin of <i>F. vesiculosus</i> , be-
low that, broad belt of <i>F. in-</i>
<i>flatus</i> , intermixed here and
there sparsely with <i>Ascophyl-</i>
<i>lum nodosum</i> . |
| I. Prasioletum <i>P. stipitatae</i> . | Under-veg. Hildenbrandietum. |
| II. Ulothricetum <i>U. flacca</i> , in great
abundance. | IV. Halosaccionetum, intermingled
with <i>Monostroma fuscum</i> , <i>Por-</i>
<i>phyra miniata</i> , <i>Rhodymenia</i>
<i>palmata</i> and a few <i>Fucus in-</i>
<i>flatus</i> . |
| Rhizoclonium in crevices. | V. Alarietum, composed of <i>Alaria</i>
<i>esculenta</i> and <i>A. Pylaii</i> . |
| III. Bangietum <i>B. fuscopurpureae</i> ,
in wonderful abundance. | VI. Laminarietum <i>L. saccharinae</i> . |
| IV. Porphyretum <i>P. umbilicalis</i> , of
great extent. | VII. Laminarietum <i>L. digitatae</i> . |
| V. Monostroma groenlandicum. | |
| VI. Fucus vesiculosus, sparse and
miserable. | |
| VII. Fucetum <i>F. inflati</i> , abundantly.
The specimens very variable. | |

South Iceland.

- Vestmannaeyjar, much exposed, steep, rocky coast. ²⁰/₅.
- I. *Olothricetum* *U. flaccæ*.
 - II. *Porphyretum* *P. umbilicalis*.
 - III. *Ascophylletum* *A. nodosi*.
 - IV. *Gigartinetum* *G. mamillosæ*, broad belt, in it *Corallina officinalis*, *Ceramium acanthotum*, *Callithamnion*, *Delesseria alata*.
 - V. *Corallinetum* *C. officinalis*, dispersed in it *Laminariae*.
- Vestmannaeyjar, Víkin, considerably exposed, sloping rocky coast. ²¹/₅.
- I. *Olothricetum* *U. flaccæ*.
Enteromorphetum *E.*micrococcae*.
Acrosiphonietum.
 - II. The *Fucus*-belt.
Ascophyllum nodosum.
F. vesiculosus.
F. inflatus.
 - III. *Gigartinetum* *G. mamillosæ* } floating
 - IV. *Corallinetum* *C. officinalis* } together.
 - V. *Laminarietum* *L.*stenophyllæ*.
 - VI. *Alarietum* *A. esculentæ*.
 - VII. *Laminarietum* *L. hyperboreæ*.
- Vestmannaeyjar, the skerry, considerably exposed, sloping rocky coast almost destitute of phanerogams. ¹⁸/₅.
- Uppermost, *Cochlearia officinalis* and rosettes of *Plantago maritima*.
At the same level, in crevices:
- I. *Enteromorphetum* *E.*micrococcae*, + *Cladophora sericea*.
 - II. *Olothricetum* *U. flaccæ* } on flat rocks
Prasioletum } between
P. stipitatae } crevices.
 - III. *Pelvetia canaliculata*.
 - IV. *Fucus spiralis*.
 - V. *Ascophylletum* *A. nodosi*.
F. vesiculosus.
F. inflatus.
Under-veg. *Callithamnionetum*.
Antithamnion.
Gigartina.
 - VI. *Gigartinetum* *G. mamillosæ*.
 - VII. *Laminarietum* *L.*stenophyllæ*.
Under-veg. *Phymatolithon polymorphum*.

South Iceland, south side of Reykjanes, according to C. H. Ostenfeld's diary.

- Staður, wide foreshore, considerably exposed. ¹²/₆.
1. *Pelvetia canaliculata*.
+ stunted *F. vesiculosus*.
 2. *Fucus spiralis*, with stunted *Ascophyllum* and *Cladophora rupestris*.
 - 3.a *Ascophyllum* + *Polysiphonia fastigiata*, broad belt.
 - 3.b *Fucus vesiculosus* formation, in it *F. inflatus*, widely distributed,
 - 3.c in it *Gigartina*.
 4. Here and there in depressions the formations:
Monostroma Grevillei and *M. fuscum*.
- + *Halosaccion*.
Cystoclonium.
Ahnfeltia.
Dictyosiphon foeniculaceum.
Rhodymenia.
5. *Laminaria* + *Alaria*.
- The foreshore between Staður and Reykjanes. ¹³/₆.
1. Uppermost, *Porphyra umbilicalis*.
F. spiralis.
F. vesiculosus f. *sphærocarpa*.
Enteromorpha compressa.
 2. *F. inflatus*-formation, widely distributed and in it *Gigartina*.

- | | |
|---|--|
| 3. <i>Gigartina</i> , widely distributed.
<i>Rhodymenia</i> .
<i>Plumaria elegans</i> .
<i>Delesseria alata</i> .
<i>Acrosiphonia</i> .
<i>Monostroma Grevillei</i> .
<i>Chaetomorpha Melagonium</i> .
<i>Delesseria sanguinea</i> and others. | 4. <i>Corallina</i> widely distributed, in a single pool <i>Halosaccion</i> .
5. <i>Laminaria</i> + <i>Alaria</i> . |
|---|--|

In another part:
Ascophyllum in quantities between
 1 and 2.

It would carry us too far to give several more examples from the diaries, but on regarding the material taken as a whole it is distinctly seen that there is no other difference of importance between the two districts with regard to the zonal division of the algal vegetation beyond the fact that some of the communities and associations occur in one place and are absent from the other. The division of the belts varies somewhat in both places which is chiefly due to the greater or smaller degree of exposure of the locality (see Part VI).

The most conspicuous difference in the division of the belts in E. Iceland and S. Iceland is due to the enormous size of the *Corallina*-belt in the latter place. This community (*Gigartina*, *Corallina* and others; see Part VI) occurs just below the *Fucus*-belt where, for instance, in the Vestmannaeyjar it is the dominant one; this also applies to Eyrarbakki and the south side of Reykjanes, but perhaps to a somewhat less degree. This leaves less room for the *Rhodymenia*-community (*Rhodymenia*, *Halosaccion*; see Part VI), which also forms a belt below the *Fucus*-belt; consequently it is not so large there as in E. Iceland where it is extremely common and in several places widely extended. In many places in SW. Iceland the *Rhodymenia*-community is as large as in E. Iceland.

The sea off the coast of S. Iceland is in movement everywhere, and calm water is almost unknown. The calm-water-vegetation proper, which is so common within the fjords of E. Iceland, is therefore absent from S. Iceland, but is again found richly represented in SW., NW. and N. Iceland.

The luxuriancy of the vegetation is somewhat similar in both places; it appears, however, to be greater in the Vestmannaeyjar and the western part of the south coast.

Depth-limit. It appears that there is reason to believe (see Part V) that the algal vegetation extends to greater depths in the fjords of E. Iceland than on the south coast, but as this cannot be regarded as sufficiently proved I shall not enter into it more fully.

VIII. SOME NOTES ON THE BIOLOGY OF THE ALGÆ ALONG THE COAST OF ICELAND.

At present very little is known with regard to the biology of the marine algæ along the coast of Iceland. What is known, on the whole, regarding this point is for the most part mentioned in the "Marine Algæ of Iceland" (31) under each species. Some observations which have been made subsequently will be mentioned in the following pages. Of these, I regard those which have been made during winter as the most important, although they are very incomplete owing to the fact that during winter I have only rarely been able to make investigations, and then have had access to the littoral zone only; thus, with the exception of a few species, the winter-habit of the sublittoral species is not known. Consequently I can, by no means, treat of the biological conditions exhaustively, but must content myself with giving a few incomplete contributions.

On the whole, the behaviour of the species is best known in spring and summer, less well in autumn, and least well during winter. From most of the coastal districts there are observations to hand either only those of a single season of the year, or at most of two or three seasons. From Reykjavík we have observations of all four seasons, but those of the winter are sparse, and only a few species have been observed throughout the year.

The observations to hand are so few and insufficient that a comparison of the biological conditions in the five coastal districts in question cannot be made; here, therefore, Iceland is treated for the most part as an entirety.

1. Duration of Life.

The life-period of the algal species is of very varying length; in this connection the algæ may be divided into two groups: annual algæ and perennial algæ.

A. Annual algæ. The annual species are especially the Green Algæ which grow in the upper littoral zone and are exposed during each low-tide. The upper littoral zone is that part of the algal region where the change of seasons is most felt and where winter prevents many species from continuing life. Such species then produce spores which live through the winter as such, or in the early stages of germination. Of annual species the following may be mentioned: —

Codiolum gregarium.	Ulothrix-species.
C. pusillum.	Ulvella.
Percursaria.	Pringsheimia.
Enteromorpha-species.	Urospora-species.
Monostroma-species.	Chætomorpha tortuosa.
Prasiola-species.	Spongomorpha vernalis.
	Cladophora-species.

In addition, some of the endophytic species must be regarded as belonging to the annuals, although some of them can be met with at all seasons of the year. As examples of such species may be mentioned: — *Chlorochytrium*-species and *Codiolum Petrocelidis*.

The life-periods of the species mentioned above are probably of different lengths and it is possible that some of them can produce several generations during one summer (cf. Børgesen, 11 and 12). The majority of these species grow luxuriantly during spring (March—May) and summer (June—August), produce spores at the end of summer and then die. Some of them, however, continue life into the autumn (September—November), or at any rate until September. A few may also be met with during winter (December—February), e. g. *Enteromorpha intestinalis* f. *prolifera*, *Monostroma fuscum* (sterile and fruiting), *Cladophora rupestris* (abundantly) and *Cladophora sericea* (sparingly).

Of the above-mentioned endophytic species I shall refer to *Chlorochytrium inclusum* and *Codiolum Petrocelidis* only. Both these species occur at all seasons of the year. They are found most frequently in the host-plants in the sublittoral zone, where the conditions of life must be considered to be more stable than in the littoral zone. I regard such species as short-lived. They are found all the year round, as probably several generations are produced during the year.

Among the annual Brown Algæ the following must be included: — *Myrionema*-species, *Ascocyclus* and the majority of the *Ectocarpaceæ*, *Leptonema*, *Litosiphon*, *Isthmoplea*, *Phæostroma*, *Ca-*

stagnea and *Leathesia* (living from June to September). In addition there are species which may be supposed to be annual, as for example, *Punctaria*, *Stictyosiphon*, *Scytosiphon* (?), *Phyllitis*, the majority of the *Dictyosiphonaceæ*, *Chorda*-species, etc.

Of Red Algæ the following must be presumed to be annual:—*Bangia*, *Porphyra*-species, *Porphyropsis*, *Conchocelis*, *Chantransia*-species, *Ceramium*-species and possibly several more. As regards *Porphyra umbilicalis* it should, however, be stated that it has been found at all seasons of the year and at Reykjavík it occurs as luxuriantly in December—January as during the spring.

B. Perennial Algæ. With regard to some of the species it is difficult to decide whether they are perennial or annual, as our knowledge of them is incomplete; consequently it is sometimes a matter of opinion whether they are to be included in the one or in the other group. Only a few of the Green Algæ are perennial, as for instance, the majority of the *Acrosiphonia*-species. The latter, besides being reproduced by spores, have also abundant vegetative reproduction by means of offshoots; and some of them, as for instance, *A. albescent* and others, live all the year round in the semi-littoral zone.

Of the Brown Algæ the *Fucaceæ* and the *Laminariaceæ* are perennial. It is, however, doubtful whether we are justified in including *Saccorrhiza dermatodea* among the perennials. At Reykjavík I have seen only old fruiting specimens in the winter, and judging from their appearance it is very probable that they die during the winter; nothing can, however, be stated with certainty regarding this point.

In the fjords of E. Iceland large individuals of this species were growing in the sublittoral zone; I believe they were more than one year old, but I could not prove this. In Greenland (Rosenvinge, 61, p. 852) perennial or upwards of a year old individuals of this species occur.

With regard to several other species of Brown Algæ it is not easy to say at present whether they are annual or perennial. I think, however, that the following may be classed as perennial:—*Lithodermà*, *Ralfsia*-species, *Sphacelaria*-species, *Chætopteris*, *Desmarestia aculeata*, *D. ligulata*, *Chordaria flagelliformis* (?).

I think that the majority of the Red Algæ are perennial or can, at any rate, live through more than one growth-period. I shall,

in the following, name some species which I am fairly certain may be included among the perennials: —

Gigartina mamillosa.	Halosaccion ramentaceum.
Ahnfeltia plicata.	Polysiphonia urceolata.
Euthora cristata.	Rhodomela lycopodioides.
Rhodophyllis dichotoma.	Odonthalia dentata.
Rhodymenia palmata (?).	Ptilota plumosa.
	Rhodochorton Rothii.

The crustaceous algæ such as *Hildenbrandia*, *Petrocelis*, *Cruoria*, *Peyssonellia* and *Rhododermis*, and by far the greater number of the calcareous algæ must also be classed as perennial.

2. Periodical Changes.

The Period of Activity. The Period of Rest. The period of activity of the annual species is identical with their period of life and it extends, probably as regards the majority of the species, over the spring and summer months. The perennial species and the species which can live more than one year, have a very long period of activity which extends over the greater part of the year with the exception of the darkest part; consequently these species have a very short period of rest. Although from the observations to hand it is not possible to fix the length of the period of rest, yet they indicate that it must be short. The *Fucaceæ* may be mentioned as an example. Their vegetative growth appears to be very slight during December—January, and in the case of the older individuals there is probably none at all at that time; but although the majority of the individuals of the *Fucaceæ* are sterile during winter yet, even in December, reproductive organs are developing here and there. Young plants of the summer or autumn appear to have vegetative growth also during the winter. In the *Fucaceæ*-belt, taken as a whole, the period of rest is consequently extremely short. In the sublittoral zone I think that entire rest must be of extremely short duration.

Renewal of the lamina. The young shoots. As is well known, a renewal of the lamina takes place yearly in the *Laminaria*-species. At what time this takes place in Iceland cannot be stated with absolute certainty, but the observations seem to indicate that the new lamina begins to grow even in the winter time, as the light increases. I believe that in SW. Iceland a general renewal of the

lamina takes place in February—March. In April individuals with large, new laminæ, with the old laminæ or portions of them still attached, are frequently found at Reykjavík, but the majority of the *Laminaria* individuals have renewed their laminæ by that time. A few individuals are however met with until June in SW. Iceland in the act of lamina-renewal. With regard to some of the most common species the following may be noted: —

Laminaria saccharina in SW. Iceland (1897) was frequently found in the lamina-renewal stage in April, while some individuals were renewing their laminæ in May. *Laminaria digitata*: some individuals were renewing their laminæ in April and until June in SW. Iceland (1897). *Laminaria hyperborea* in SW. Iceland (1897), some were renewing their laminæ in May—June.

L. hyperborea was found renewing its laminæ in July on the north coast of Iceland. This was observed only once, therefore it cannot be concluded from this that the lamina-renewal stage commences later or lasts longer on the north coast than in SW. Iceland.

In the Færøes (Börgesen, 11 and 12) the lamina-renewal stage occurs at the same time as in SW. Iceland.

On the west coast of Sweden the renewal of the lamina takes place during winter (Kylin, 45) and in *Laminaria saccharina* and *L. digitata* the young leaf, in December, is a quarter the size of the old one; in April it is only exceptionally that individuals are found with a portion of the old lamina attached. The renewal of the lamina in *L. hyperborea* takes place later, and in April the new lamina is a quarter the size of the old one, and in the beginning of July a portion of the old lamina is still present.

In connection with the lamina-casting species the following may be mentioned: —

Desmarestia aculeata has been collected bearing the brown, assimilatory hairs in March—May in SW. Iceland, in May in NW. Iceland, in June in E. Iceland, and in July in N. Iceland. This appears to indicate that the hair-bearing stage occurs later on the north and east coasts, or that it lasts longer. The species behaves in the same manner in Greenland (Rosenvinge, 61, p. 857) where the hairs are cast off, at the latest, in June in South Greenland, while hair-bearing individuals are found in July and August in North Greenland. In the Færøes it has been observed with hairs upon it in May—June (Börgesen, 13, p. 445), but hair-bearing individuals were, however, rare in June. On the west coast of

Sweden (Kylin, 45) the hairs are cast in June, but (young) hair-bearing individuals may, however, be met with in July.

Polysiphonia urceolata has hair-leaves in the spring, summer and beginning of autumn, but individuals without hairs are found side by side with hair-bearing ones from May to August. In December only hairless individuals have been observed at Reykjavík, and in January—February only hairless plants have been collected in N. Iceland.

Rhodomela lycopodioides has been collected with hair-leaves in March—July, and hairless in June—August in SW. Iceland; with hair-leaves in April—December, and hairless in July—August in N. Iceland; with hair-leaves in June—July and hairless in May—July in E. Iceland. In the autumn this species had cast off its leaves and branches in SW. Iceland.

In addition to this, the following instances of the occurrence of young shoots may be mentioned: —

Odonthalia dentata. The young shoots in this species are readily recognized by their paler red colour. Material from January—February bears young shoots. The latter are easily recognizable in January, and have probably begun to grow out in December. The young shoots then increase in size, and the colour becomes gradually darker month by month. In material collected in June—July the length of the year's shoot may even then be determined in some of the individuals, but I believe, however, that it is in July that the shoot is almost full-grown.

Polysiphonia fastigiata has young shoots in December at Reykjavík.

Odonthalia shows distinctly the period of development of the vegetative shoots in the sublittoral zone, and I presume it may be taken for granted that the other sublittoral species do not differ very much from it as regards this point.

In Greenland the formation of the new shoots begins in February—March (Rosenvinge, 63, p. 239), and the growth is continued until August or during the whole summer.

In the Færøes the new shoots begin to appear in the latter part of autumn (Börgesen, 12, p. 828).

From Spitzbergen (Kjellman, 36) some sublittoral species are known which form new shoots during the winter, as for instance, *Delesseria sinuosa* in January, and *Rhodymenia palmata* from November to May.

The Fruiting Period. In the table given below is indicated the time at which the species have been found in fruit. A + signifies that the greater part of the individuals in the samples gathered were fruiting; a $\pm$ signifies that fruiting and sterile individuals occurred in almost equal abundance, or sometimes that only a few fruiting individuals occurred; a — signifies that only sterile individuals of the species were found.

In the majority of the annual species the fruiting period coincides with the vegetative stage, and thus growing vegetative shoots and sporangia are frequently found on the same individual. These species fruit comparatively quickly and the young, or purely vegetative, stage is of short duration. The fruiting period extends over spring and summer probably in the case of the majority of the species. They do not, however, behave similarly in this respect in the different coastal districts. *Urospora Wormskioldii*, *Monostroma Grevillei*, *M. undulatum*, *Ectocarpus tomentosoides* and *Litosiphon filiformis* are all decidedly spring plants at Reykjavík, but in E. Iceland they have been found bearing fruit far into the summer. *Leathesia difformis* is a decidedly summer species at Reykjavík, it has been observed fruiting in June, July, August and even into September, but it was dying away in the middle of September. At Reykjavík its life-period coincides with its fruiting-period, but in N. Iceland it has been gathered in a sterile condition in September. This species appears to behave in the same manner on the west coast of Sweden (Kylin, 45) as at Reykjavík. Moreover the fact may be emphasized that at the latter place *Enteromorpha Linza* is usually a summer and autumn species.

With regard to the perennial species, it happens both that the vegetative growth and the fruit-formation is simultaneous, and also that the two stages occur at different times. A purely vegetative, young stage, more prolonged than in the annuals, is found in several of the perennials; thus, I think that I have seen indications of *Alaria* and *Laminaria* species being in a purely vegetative stage throughout the first year and perhaps longer.

Kylin (45, p. 274) divides the perennial species into three groups according to their life-activity: —

Group 1 includes species which carry on vegetative and reproductive work all the year round.

Group 2. Species which carry on vegetative work the whole year, but reproductive work only for a part of the year.

Group 3. Species which carry on vegetative and reproductive work only during a part of the year.

In referring the Icelandic species to these groups the difficulty at once arises, that we lack knowledge regarding the behaviour of a number of the species during winter. Such species cannot therefore be grouped with any certainty at the present time. True, we may judge with some probability how they behave here during winter by a comparison of their winter-activities in other places, provided these are known; but as it has been shown that one and the same species often behaves differently in two distantly situated places, a satisfactory result could not be arrived at through such a comparison which has, for that reason, been omitted. I therefore mention a few species only, which I think I can group with some certainty.

Group 1. The following species belong to this group: — *Hildenbrandia rosea* which fruits all the year round. *Rhodymenia palmata*: it might appear doubtful whether this species should be classed as a perennial. Kjellman (36, p. 150) regards it as an annual plant which forms tetraspores twice, once as a young plant and the second time just before it dies. It appears to me that the new shoots which arise early in spring from evidently old fronds, show that it lives through at any rate more than one period of growth. *Pelvetia canaliculata* bears fruit and carries on vegetative work the whole year at Reykjavík. In December—January the fruiting individuals were comparatively few, but there was a quantity of young plants almost all of which were in the "rosette" stage. It is perhaps doubtful if this species belongs to this group at all.

Group 2. The *Fucaceæ* belong to this group (with the exception of *Pelvetia* (?)). *Fucus spiralis* produces fruit in spring, summer and autumn. In December (1911) it was sterile, and young plants were found in quantities.

Ascophyllum nodosum, *Fucus vesiculosus* and *Fucus inflatus*, all these behave almost similarly. In December and January I saw, here and there, individuals with very young receptacles, but by far the greater part were sterile. In spring and early summer these species are found everywhere with full-grown receptacles. In the latter half of August they are sterile everywhere and at that time only a few individuals, which must be regarded as stragglers, are found bearing receptacles. Of *F. inflatus* I saw no stragglers in August. In September also they are sterile. In the first half of October

both *Ascophyllum* and *F. inflatus* are sterile, but at that time a few individuals of *F. vesiculosus* bear young receptacles. From the middle of October until December there are no observations to hand from Reykjavík. The usual course, with regard to these species, appears to be as follows: In the latter part of the autumn the development of the sexual organs begins, and is continued throughout the winter; in March the species are found everywhere with ripe sexual organs and the spores continue their development until the latter part of the summer.

Kjellman (36, p. 195) records with regard to *Ascophyllum nodosum* in Finmark, that it had numerous receptacles in July and the first half of August, was sterile in the latter part of August, and that new receptacles had begun to appear in October. Foslie (18, p. 64) records with regard to the same species in East Finmark that it has abundant receptacles in July and is sterile in August.

In the Færøes (Börjesen, 12, p. 830) *Ascophyllum nodosum* has young receptacles in December and fruits during the whole summer.

On the west coast of Sweden the sexual organs begin to develop late in August or early in winter (Kylin, 45, p. 106), and by the beginning of June the receptacles have fallen off.

Fucus inflatus probably behaves in East Finmark in a similar manner as at Reykjavík. Foslie (18, p. 67) mentions receptacle-bearing individuals in June—July and the first part of August. At Spitzbergen it bears fruit during winter and Kjellman (36, p. 204) found germinating spores in December, January, February and March.

To Group 2 belong, in addition, probably all the *Laminariaceæ*, *Rhodochorton Rothii*, *Polysiphonia urceolata*, *Halosaccion*, *Gigartina mamillosa*, *Odonthalia* and probably many more. *Petrocelis Hennesdyi* belongs also most nearly to this group; it has been found producing fruit the whole year, but in spring, summer and autumn only a few fruiting crusts are found, while the winter appears to be the ordinary fruiting period. *Chætopteris plumosa* I include, although with doubt, in this group.

Group 3. To this belong *Desmarestia aculeata*, which has been found fruiting in October, *Rhodomela lycopodioides*, *Delesseria sanguinea* and others.

The Fruiting-period of the Species.

	Spring	Summer	Autumn	Winter
<i>Bangia fuscopurpurea</i>	+	+	+	
<i>Porphyra umbilicalis</i>	+	±	±	±
<i>P. miniata</i>	—	±	±	
<i>Porphyropsis coccinea</i>	—	—		
<i>Conchocelis rosea</i>	—	—	—	
<i>Chantransia microscopica</i>			—	
<i>C. Alariæ</i>		+		
<i>C. secundata</i>	+	±	±	
<i>C. virgatula</i>	+	±		
<i>Chondrus crispus</i>	+	+		
<i>Gigartina mamillosa</i>	—	+	±	—
<i>Ahnfeltia plicata</i>	—	—	—	—
<i>Phyllophora Brodiaei</i> * interrupta.....	—	—		
<i>P. membranifolia</i>	—	—	—	
<i>Actinococcus subcutaneus</i>	—	—		
<i>Ceratocolax Hartzii</i>	+			
<i>Cystoclonium purpurascens</i>	—	—	±	
<i>Turnerella Pennyi</i>	—	—		
<i>Euthora cristata</i>	±	±	+	
<i>Rhodophyllis dichotoma</i>	±	±		
<i>Rhodymenia palmata</i>	±	±	±	±
<i>Lomentaria clavellosa</i>	—	±		
<i>L. rosea</i>	—			
<i>Plocamium coccineum</i>	±	+	—	
<i>Halosaccion ramentaceum</i>	±	±	—	±
<i>Delesseria alata</i>	±	±	—	
<i>D. sinuosa</i>	±		±	
<i>D. sanguinea</i>	—	—	±	+
<i>Pterosiphonia parasitica</i>	+			
<i>Polysiphonia urceolata</i>	±	±	±	—
<i>P. fastigiata</i>	±	±	—	±
<i>P. arctica</i>	—	±	—	
<i>P. nigrescens</i>			+	
<i>Rhodomela lycopodioides</i>	+	+	±	—
<i>Odonthalia dentata</i>	—	±	±	+
<i>Callithamnion Arbuscula</i>	±	+		
<i>C. scopulorum</i>	±	±		
<i>Plumaria elegans</i>	±		+	—
<i>Ptilota plumosa</i>	±	±	+	+
<i>P. pectinata</i>	±	±	±	
<i>Antithamnion Plumula</i> * boreale.....	—	±		
<i>A. floccosum</i>	±	±		
<i>Ceramium acanthonotum</i>	—	—		
<i>C. Deslongchampsii</i>		—		
<i>C. fruticulosum</i>		+		

The Fruiting-period of the Species (continued).

	Spring	Summer	Autumn	Winter
<i>Ceramium circinnatum</i>		+		
<i>C. arborescens</i>		+		
<i>C. atlanticum</i>	—	+		
<i>C. rubrum</i>	+	+	+	
<i>Rhodochorton Rothii</i>	+	+	—	—
<i>R. repens</i>	+			
<i>R. minutum</i>		+		
<i>R. penicilliforme</i>	+	+		
<i>R. membranaceum</i>	+	+		
<i>Dumontia filiformis</i>	+	+		
<i>Dilsea edulis</i>		—		
<i>Petrocelis Henedyi</i>	+	+	+	+
<i>Cruoria arctica</i>	—	+		
<i>C. pellita</i>		+		
<i>Peyssonellia Rosenvingii</i>	—	—	—	
<i>Rhododermis parasitica</i>	+	+		
<i>Lithothamnion glaciale</i>	—	—	—	
<i>L. Ungerii</i> ..	—	—		
<i>L. tophiforme</i>		—	—	
<i>L. flavescens</i>		—		
<i>L. foecundum</i>		—		
<i>L. læve</i>	—	—		
<i>L. Lenormandi</i>	—	—		
<i>Phymatolithon polymorphum</i>	—	—		
<i>Clathromorphum compactum</i>	—	—	—	—
<i>Lithophyllum Crouani</i>	—	—		
<i>Dermatolithon macrocarpum</i>	+	+		
<i>Corallina officinalis</i>	—	+	—	
<i>Hildenbrandia rosea</i>	+	+	+	+
Phæophyceæ.				
<i>Lithoderma fatiscens</i>	—	+	—	—
<i>Petroderma maculiforme</i>				+
<i>Ralfsia ovata</i>		+	+	
<i>R. clavata</i>	+	+	—	+
<i>R. verrucosa</i>		+	+	
<i>R. deusta</i>	—	—	—	
<i>Myrionema vulgare</i>	—	—		
<i>M. Corunnæ</i>	+	+		
<i>M. globosum</i>	+	+	+	
<i>M. færøense</i>	+			
<i>M. Laminariæ</i>		+		
<i>Ascocyclus islandicus</i>			+	
<i>Microsyphar Polysiphoniæ</i>		+		
<i>Streblonema acidoides</i>		+	+	

The Fruiting-period of the Species (continued).

	Spring	Summer	Autumn	Winter
<i>Streblonema Stilophoræ</i> v. <i>cæspitosa</i>	+	+	+	
<i>Pylaiella littoralis</i>	+	+	+	—
<i>Ectocarpus tomentosoides</i>	+	+	+	
<i>E. tomentosus</i>	+	+		
<i>E. confervoides</i>	+	+	+	
<i>E. siliculosus</i>	+	+	+	
<i>E. penicillatus</i>	+	+		
<i>E. fasciculatus</i>	+	+		
<i>E. Hinksiae</i>	+			
<i>Leptonema fasciculatum</i> v. <i>subcylindrica</i> ..	+	+	+	
<i>Elachista fucicola</i>	±	±	±	±
<i>Sphacelaria britannica</i>	±	—	—	
<i>S. radicans</i>	—	±		+
<i>S. olivacea</i>	—			
<i>Chætopteris plumosa</i>	—	—	—	+
<i>Omphalophyllum ulvaceum</i>		+		
<i>Punctaria plantaginea</i>	±	—	+	
<i>Litosiphon filiformis</i>	+	+	±	
<i>Isthmoplea sphærophora</i>	±	+		
<i>Stictyosiphon tortilis</i>	—	±		
<i>Phaeostroma pustulosum</i>	+	+		
<i>Scytosiphon Lomentaria</i>	+	+	+	
<i>Phyllitis zosterifolia</i>	+	±	—	
<i>P. fascia</i>	±	±	±	
<i>Coilodesme bulligera</i>	+	+		
<i>Dictyosiphon Ekmani</i>		+		
<i>D. Mesogloia</i>		+	+	
<i>D. Chordaria</i>		+		
<i>D. corymbosus</i>		+		
<i>D. hippuroides</i>		+	+	
<i>D. foeniculaceus</i>	—	±		
<i>Desmarestia viridis</i>	—	—	—	
<i>D. aculeata</i>	—	—	+	—
<i>D. ligulata</i>		—		
<i>Castagnea virescens</i>		+	+	
<i>Leathesia difformis</i>		+	±	
<i>Chordaria flagelliformis</i>	—	±	+	+
<i>Chorda tomentosa</i>		+		
<i>C. Filum</i>	—	±	+	
<i>Saccorrhiza dermatodea</i>	—	±	±	+
<i>Laminaria saccharina</i>	±	±	—	+
<i>L. færøensis</i>		+		—
<i>L. nigripes</i>		—		
<i>L. digitata</i>	±	±	±	—
<i>L. hyperborea</i>	+	—	—	—

The Fruiting-period of the Species (continued).

	Spring	Summer	Autumn	Winter
<i>Alaria Pylaii</i>	—	+	+	
<i>A. esculenta</i>	—	+	+	—
<i>Fucus spiralis</i>	+	+	+	—
<i>F. inflatus</i>	+	+	—	—
<i>F. serratus</i>	+		+	
<i>F. vesiculosus</i>	+	+	+	+
<i>Pelvetia canaliculata</i>	+	+	+	+
<i>Ascophyllum nodosum</i>	+	+	+	—
Chlorophyceæ.				
<i>Chlorochytrium Cohnii</i>		+		
<i>C. inclusum</i>		+	—	—
<i>C. dermatocolax</i>	—	—	—	
<i>C. Schmitzii</i>		—		
<i>Codiolum Petroceldis</i>	—	—	—	—
<i>C. gregarium</i>		—		
<i>C. pusillum</i>			+	
<i>Percursaria percursa</i>		+		
<i>Enteromorpha aureola</i>		+		
<i>E. Linza</i>	—	—	+	
<i>E. intestinalis</i>	+	+	+	—
<i>E. clathrata</i> ..		+	—	
<i>Monostroma groenlandicum</i>	—	+		
<i>M. Grevillei</i>	+	+		
<i>M. undulatum</i>	+	+		
<i>M. fuscum</i>	+	+	+	+
<i>Ulva lactuca</i>	+	+	—	
<i>Prasiola polyrrhiza</i>	—			
<i>P. furfuracea</i>		—		
<i>P. stipitata</i>	—		—	—
<i>Ulothrix consociata</i> var. <i>islandica</i>	—	+		
<i>U. subflaccida</i>		+	—	
<i>U. pseudoflacca</i>	+	+		
<i>U. flacca</i>	+	+		
<i>Pseudendoclonium submarinum</i>		—		
<i>Entoderma Wittrockii</i>	+	—	—	
<i>Acrochæte parasitica</i>	—			
<i>A. repens</i>		+		
<i>Bolbocoleon piliferum</i>		+	+	
<i>Ulvella fucicola</i>	—	—	—	
<i>Pringsheimia scutata</i>	—	+		
<i>Ochlochæte ferox</i>			+	
<i>Urospora mirabilis</i>	+	+	+	
<i>U. Hartzii</i>	+	+		
<i>U. Wormskioldii</i>	+	+		

The Fruiting-period of the Species (continued).

	Spring	Summer	Autumn	Winter
<i>Chætomorpha tortuosa</i>	—	—	—	
<i>C. Melagonium</i>	+	+	—	
<i>Rhizoclonium riparium</i>	—	+	—	—
<i>Spongomorpha vernalis</i>		+	+	
<i>Acrosiphonia albescens</i>	+	+	+	
<i>A. incurva</i>	+	+	+	
<i>A. hystrix</i>	+	+		
<i>A. flabelliformis</i>	—			
<i>A. penicilliformis</i>		+		
<i>Cladophora rupestris</i>	+	—	+	—
<i>C. hirta</i>	—		+	
<i>C. sericea</i>	+	+	+	—
<i>C. glaucescens</i>		—		
<i>C. gracilis</i>		—	—	
<i>Gomontia polyrrhiza</i>	+	+	+	
<i>Ostreobium Queketti</i>	—	—	—	
Cyanophyceæ.				
<i>Pleurocapsa amethystea</i>	—	—	—	—
<i>Plectonema norvegicum</i>			—	
<i>Phormidium autumnale</i>		—		
<i>Spirulina subsalsa</i>		—	—	
<i>Calothrix scopulorum</i>		—	—	
<i>Rivularia atra</i>			—	

By looking through the above table it is seen that in the case of a number of species the fructification-period is of long extent. Some nine species have been found fruiting all the year round, but I presume that by future investigations it will be proved that many more species bear fruit during the whole year. Kjellman (36) mentions 11 species which bear fruit all the year round in the Arctic Sea, and Rosenvinge (63) mentions 6 species which fruit all the year round along the coast of Greenland, and he adds that probably there are many more.

If we consult the table as to which season of the year is richest in fruit-bearing species it is easily seen that summer stands highest, with 64 % of the total number of species; then comes spring with 42 %, and after that autumn with 33 %. As the conditions during winter are so very little known no percentages can be given for that season.

It is well-known (Kjellman, Rosenvinge, Börgesen) that

in the case of many species both the vegetative period and the period of fructification is longer in the Arctic Sea and the northern part of the Atlantic Ocean than in the remaining more southern part of the boreal area of the same Ocean. It holds good also for Iceland, that both these periods are prolonged. Iceland, the Færøes and Greenland agree also in the fact that the summer is richest in fruit-bearing species.

3. Littoral Winter-vegetation at Reykjavík.

The littoral vegetation changes its appearance according to the season, and this is especially owing to the annual species. The vegetation is most luxuriant, and richest in species during spring and early summer; in the latter part of the summer the annual species decrease in number and a quantity of them disappear, and in the autumn only a small number of them is left. During winter only a few short-lived species are found, and some of them play either no part, or only an unimportant one in the vegetation which by that time is usually composed of perennial species. Thus, the number of the species of the winter-vegetation is much less than of the summer-vegetation because the *Chlorophyceæ*, which is the group in the littoral zone that is richest in species during summer, are few in number during winter; also the number of species of the *Phæophyceæ* is greatly reduced in the littoral zone during winter. It is the *Fucaceæ* which form by far the greater part of the mass of plants in the littoral zone, during the winter as in the other seasons of the year.

In December and January, in the winter 1911—1912, the vegetation of the upper and lower littoral zones was composed as follows: —

Highest of all a *Prasioletum stipitatæ* occurred in patches. *Prasiola stipitata* grew luxuriantly and had a normal appearance. It was not injured by the winter climate.

Below that came a well-developed *Porphyretum umbilicalis*, occurring also in patches on account of the surface-form of the coast. The *Porphyra* was both sterile and in fruit and had an entirely normal appearance.

Below that again came the *Fucaceæ*-community which, as is usually the case there, consisted at the top of a *Pelvetia-Fucus spiralis*-belt and at the bottom of the usual *Fucus*-belt (*Fucus vesi-*

culosus, *Ascophyllum nodosum* and *Fucus inflatus*). The vegetation was as luxuriant during winter as in the other seasons of the year when, however, the epiphyte-vegetation of the *Fucus*-belt is excepted. For further information concerning the *Fucaceæ* see p. 173. Epiphytes, for instance such as *Pylaiella littoralis* and *Elachista fucicola*, which at the other seasons of the year are common everywhere in the *Fucus*-belt, were not observed. On the other hand, *Polysiphonia fastigiata* occurred in abundance on *Ascophyllum*. Of intermixed species in the *Fucus*-belt *Cladophora rupestris* may specially be mentioned; it occurred abundantly as well-developed specimens with the uppermost apex of the shoots destroyed.

A Hildenbrandietum occurred everywhere in the littoral zone, of similar appearance and extent as at the other seasons of the year.

In rock-crevices at the level of the *Fucus*-belt a well-developed *Rhodochorton* *Rothii* was found. The *Rhodochorton* was sterile and *Pleurocapsa amethystea* was growing upon it. In such crevices were noted in addition: — *Pylaiella littoralis*, sterile and in very small quantity; *Acrosiphonia* sp., a few filaments; *Cladophora rupestris*, abundant; *Polysiphonia urceolata*, sterile and without hairs and sparse, and *Callithamnion* sp.

The vegetation of the Pools was on the whole very poorly developed. The upper pools, at the level of *Pelvetia* and *Fucus spiralis*, contained a few small individuals of *Cladophora sericea* f., a few filaments of *Pylaiella littoralis*, a few small individuals of *Monostroma fuscum*, and Diatoms in abundance. In such pools *Cladophora sericea* forms a dense and luxuriant vegetation in spring and summer. *Fucus inflatus* f. *linearis* grows also in these pools in spring and summer, but was not found there in winter. It appears as if this form is annual, at any rate in the upper pools. The lower pools, almost at the level of the lower part of the *Fucus*-belt, contained only a poor vegetation. *Monostroma fuscum*, however, occurred fairly abundantly, but *Halosaccion ramentaceum* was found more sparsely; on *Halosaccion* was growing *Elachista fucicola* v. *lubrica* with unilocular sporangia and somewhat sparse assimilatory filaments, and also *Ceramium* sp.

Below the *Fucus*-belt, in the lower littoral zone (upper part of the semilittoral belt) were found at Efferseyjargrandi, *Rhodymenia* distributed in patches here and there, many of them of rather considerable size. The majority of the individuals were old,

with abundance of new shoots. The *Rhodymenia*-vegetation is never really luxuriant in this place; it attains, however, to a greater luxuriance in spring and summer than during winter. *Halosaccioneta* occurred also here and there, but sparsely and not nearly as abundantly as in spring and summer, but the same applies to it, as to *Rhodymenia*, that it never grows really luxuriantly in this place. There were noted in addition: — *Monostroma fuscum*, *Pyraliella littoralis* (extremely sparsely) and *Enteromorpha intestinalis* f. *prolifera*, also extremely sparsely. *Lithodermeta* occurred abundantly and were well-developed, but the species was sterile. A *Sphacelarietum* composed of *Sphacelaria radicans* was found here and there. The plants were low in growth, sterile and without hairs. A *Gigartinetum* occurred here and there of about the usual extent.

Just below the limit of low-tide I gathered the uppermost stragglers from the sublittoral zone. There *Laminaria saccharina*, *L. digitata*, *L. hyperborea* and *Alaria esculenta* f., were growing. All the *Laminarias* were sterile and the new laminæ had not begun to grow. The frond of the *Alaria* was usually torn in pieces; in the middle of the stipe there were old sporophylls. The uppermost part of the stipe, just below the leaf-base, was young and evidently growing. Lowermost in the part that was growing, small projections could be seen on the two sides, which were evidently the beginnings of new sporophylls.

The following species were found thrown ashore: — *Laminaria saccharina*, *L. digitata*, *L. hyperborea*, *Alaria esculenta* f., *Saccorrhiza dermatodea*, *Desmarestia aculeata*, *Odonthalia dentata*, *Petrocelis Hennedyi* richly fruiting (on *L. hyperborea*), *Rhodochorton Rothii* (on *L. hyperborea*), *Delesseria sanguinea* with the small tetraspore-bearing fronds, and *Plilota plumosa* with tetraspores.

For the further understanding of the winter-life of the algæ it may be mentioned that the winter of 1911—1912 was unusually mild at Reykjavík.

BIBLIOGRAPHY.

1. Agardh, C. A., *Icones algarum ineditæ. Fasciculi qui exstant duo. Editio nova*, Lundæ, 1846.
2. — *Species algarum rite cognitæ, I-II, Gryphisvaldiæ*, 1821—1828.
3. Agardh, J. G., *Bidrag till kännedomen af Spetsbergens alger, med Tillæg. Kgl. Sv. Vetensk. Akad. Handlingar, Bd. 7, N° 8, Stockholm*, 1868.
4. — *De Laminariis symbolas offert. Lunds Universitets Årsskrift. Tom. IV*, 1867.
5. — *Species genera et ordines algarum. Vols. I-III, Lundæ et Lipsiæ*, 1848—1876.
6. Ahlner, K., *Bidrag till kännedomen om de svenska formerna af algslågtet Enteromorpha. Stockholm*, 1877.
7. Areschoug, J. E., *Observationes Phycologicæ. Particula prima, de conferva-cis nonnullis. Upsaliæ*, 1866.
8. — *Phyceæ scandinavicæ marinæ sive Fucearum nec non Ulvacearum, quæ in maribus pænisulæ scandinavicæ alluentibus crescunt, descriptiones. Upsaliæ, MDCCCL.*
9. Berthold, G., *Ueber die Vertheilung der Algen im Golf von Neapel. Mitth. aus der zool. St. zu Neapel, III Bd., 4. Heft.*
10. Boye, P., *Bidrag til Kundskaben om Algevegetationen ved Norges Vestkyst. Bergens Mus. Aarbog, 1894—95, N° XVI.*
11. Børgesen, F., *Om Algevegetationen ved Færøernes Kyster. Kjöbenhavn og Kristiania*, 1904.
12. — *The Algæ-Vegetation of the Færøese Coasts. Botany of the Færøes. Part III. Copenhagen*, 1905.
13. — *The Marine Algæ of the Færøes, Botany of the Færøes, Part II, Copenhagen*, 1902.
14. — and Helgi Jónsson, *The Distribution of the Marine Algæ of the Arctic Sea and the northernmost part of the Atlantic. Published Aug. 1905, Botany of the Færøes, Part III, Copenhagen*, 1908.
15. De la Pylaie, *Flore de l'île de Terre-Neuve et des îles St. Pierre et Miclon. Paris*, 1829.
16. Farlow, W. G., *Marine Algæ of New England and adjacent coast. Washington 1881. Reprinted from Report of U. S. Fish. Commission, 1879.*
17. Falkenberg, P., *Die Meeresalgen des Golfes von Neapel. Mitth. aus der zool. St. zu Neapel, I Bd., 2. Heft.*
18. Foslie, M., *Contribution to the Knowledge of the Marine Algæ of Norway. I, East-Finmarken. Tromsø Mus. Aarshefter 13, Reprint, Tromsø*, 1890.
19. — *The Norwegian forms of Lithothamnion. Det Kgl. norske Vidensk. Selsk. Skrifter, 1894. Trondhjem*, 1895.
20. — *Ueber die Laminarien Norwegens. Kristiania Vidensk. Selsk. Forh., 1884, Nr. 14. Kristiania*, 1884.

21. Foslie, M., Om nogle nye arctiske havsalger. Kristiania Vidensk. Selsk. Forh. 1881. Nr. 14.
22. — Nye havsalger. Tromsø Mus. Aarshefter. Tromsø, 1887.
23. Gran, H. H., Algevegetationen i Tönsbergfjorden. Kristiania Vidensk. Selsk. Forh. for 1893. Kristiania, 1893.
24. — Kristianiafjordens Algeflora. Vidensk. Selsk. Skrifter, I Mathem.-nat. Klasse, 1896, No 2, Kristiania, 1897.
25. Hansteen, B., Algeregioner og Algeformationer ved den norske Vestkyst. Nyt Magazin for Naturvidenskaberne. 1892, Kristiania.
26. Harvey, W. H., Phycologia Britannica, Vols. I-III. London, 1846—1851.
27. Helland-Hansen, Björn and Nansen, Fridtjof, The Norwegian Sea Report on Norwegian Fishery and Marine-Investigations. Vol. II, 1909, No 2. Kristiania, 1909.
28. Huber, J., Contributions à la connaissance des Chætophorées épiphytes et endophytes et leur affinités. Ann. scienc. nat. VII Série, 1892, vol. 16.
29. Imhäuser, L., Entwicklungsgeschichte und Formenkreis von Prasiola, Flora, 1889.
30. Icones Floræ Danicæ, Vols. 1-16, Hauniæ, 1766—1877.
31. Jónsson, Helgi, The Marine Algæ of Iceland, I-IV, Bot. Tidsskrift, 24-25. Bd. Kjöbenhavn, 1902—1903.
32. — The Marine Algæ of East-Greenland, Meddel. om Grönland, XXX. Copenhagen, 1904.
33. — Om Algevegetationen ved Islands Kyster. Köbenhavn, 1910.
34. Kjellman, F. R., Über Algenregionen und Algenformationen im östlichen Skager Rack. Bih. till K. Svensk Vet. Ak. Hdl. Bd. 5, No 6. Stockholm, 1878.
35. — Handbok i Skandinavians hafsalg-flora, I, Fucoidæ. Stockholm, 1890.
36. — The Algæ of the Arctic Sea. Kungl. Svenska Vetensk. Akad. Hdl. Bd. 20, No 5. Stockholm, 1883.
37. — Zur Kenntniss der marinen Algenflora von Jan Mayen, Arkiv för Botanik Bd. 5, No 14. Upsala & Stockholm, 1906.
38. — Ueber die Algenvegetation des Murmanschen Meeres an der Westküste von Novaja Semlja und Wajgatsch. Upsala, 1877.
39. — Bidrag, till kannedomen om Islands hafsalg-flora, Bot. Tidsskrift 3. Række 3. Bd. Kjöbenhavn, 1879.
40. — Om Spetsbergens marina klorofyllförande thallophyter. Bih. till Kung. Sv. Vet. Akad. Hdl. Bd. 3, Nr. 7, 1875, and Bd. 4, Nr. 6, 1877.
41. — Studier öfver Chlorophycæslægtet Acrosiphonia J. Ag. och dess scandinaviske arter. Bih. till Kung. Sv. Vet. Akad. Hdl. Band 18, Afd. III, No 5.
42. — Blastophysa polymorpha och Urospora incrassata. Bih. till Kung. Sv. Vet. Ak. Hdl. Bd. 23, Afd. III, No 9.
43. Kleen, E., Om Nordlandenes högra hafsalgar. Öfversigt af Kung. Vet. Akad. Förh., 1874, No 9, Stockholm.
44. Knudsen, Martin, Contribution to the Hydrography of the North Atlantic Ocean. Meddelelser fra Kommissionen for Havundersøgelser. Serie: Hydrografi Bind I, Nr. 6. Köbenhavn, 1905.
45. Kylin, Harald, Studien über die Algenflora der schwedischen Westküste Upsala, 1907.
46. Kuckuck, P., Beiträge zur Kenntniss der Meeresalgen. Sonderabdruck aus: Wissenschaftliche Meeresuntersuchungen, herausgegeben von der Kommission

- zur Untersuchung der deutschen Meere in Kiel und der Biologischen Anstalt von Helgoland. Neue Folge. II Bd., Heft. I. Kiel und Leipzig, 1897.
47. Kuckuck, P., Bemerkungen zur marinen Algenvegetation von Helgoland. Sonderabdruck aus: Wissenschaftliche Meeresuntersuchungen, herausgegeben, etc. Neue Folge. I Bd., 1894, II Bd., 1897. Kiel und Leipzig.
 48. — Beiträge zur Kenntniss einiger Ectocarpus-Arten der Kielerförhde. Separat-abdruck des Bot. Centralblattes, 1891, Bd. 48.
 49. Le Jolis, Auguste, Examen des espèces confondues sous le nom de *Laminaria digitata* Auct.N. Act. Ac. Leop.-Car. Vol. 25, 1856.
 50. — Liste des Algues marines de Cherbourg. Paris, 1863.
 51. Lyngbye, H. C., Tentamen Hydrophytologiæ Danicæ. Hafniæ, 1819.
 52. Nielsen, J. N., Contribution to the Hydrography of the Waters North of Ice-land. Meddel. fra Kommissionen for Havundersøgelser. Serie: Hydrografi, Bind I, Nr. 7. København, 1905.
 53. — Contribution to the Hydrography of the North-eastern Part of the Atlantic Ocean. Meddel. fra Kommissionen for Havundersøgelser. Serie: Hydrografi, Bind I, Nr. 9. København, 1907.
 54. Oltmanns, F., Morphologie und Biologie der Algen. Zweiter Band. Jena, 1905.
 55. Paulsen, Ove, Plankton-Investigations in the Waters round Iceland in 1903. Meddel. fra Kommissionen for Havundersøgelser. Serie: Plankton, Bd. I, Nr. 1, 1904. Kjøbenhavn, 1904.
 56. — Plankton-Investigations in the Waters round Iceland and in the North At-lantic. Meddel. fra Kommissionen for Havundersøgelser. Serie: Plankton, Bd. I, Nr. 8. Kjøbenhavn, 1909.
 57. Petersen, Henning E., Ceramium-Studies I and II. Særtryk af Bot. Tidsskr. 31. Bind. København, 1911.
 58. Reinke, J., Algenflora der westlichen Ostsee deutschen Antheils. Kiel, 1889. VI. Bericht der Kommission zur Untersuch. d. deutschen Meere in Kiel.
 59. — Atlas deutscher Meeresalgen. Im Auftrage des K. preuss. Minist. für Land-wirtschaft, Domänen und Forsten, herausgegeben im Interesse der Fischerei von der Kommission zur wiss. Untersuch. d. deutschen Meere. Kiel, 1889—92.
 60. — Beiträge zur vergleichenden Anatomie und Morphologie der Sphacelariaceen. Bibliotheca Botanica, Heft 23. Cassel, 1891.
 61. Rosenvinge, L. Kolderup, Grønlands Havalger. Meddel. om Grønland, III. Kjøbenhavn, 1893.
 62. — Deuxième mémoire sur les Algues marines du Grønland. Meddel. om Grøn-land, XX. Kjøbenhavn, 1898.
 63. — Om Algevegetationen ved Grønlands Kyster. Meddel. om Grønland, XX. Kjøbenhavn, 1898.
 64. — On the Marine Algæ from North-east Greenland. Danmark-Ekspeditionen til Grønlands Nordøstkyst, 1906—1908. Bind III, Nr. 4. Meddel. om Grønland, XLIII.
 65. — The Marine Algæ of Denmark, Part I. K. Danske Vidensk. Selsk. Skr. 7. Række. VII. Nr. 1, Kjøbenhavn, 1909.
 66. Sauvageau, C., Sur quelques Myrionémacées. Ann. d. sc. nat. 8. Serie, Botanique. Tome V. Paris, 1907.
 67. — Remarques sur les Sphacélariacées. Journal de Botanique. Tome XIV, 1900, and Tome XV, 1901.
 68. Schmidt, Johs., Danmarks blaa grønne Alger (Cyanophyceæ Daniæ), I, Bot. Tidsskrift. Kjøbenhavn, 1899.

69. Schmitz, Fr., Die Chromatophoren der Algen. Verh. d. nat. Ver. d. preuss. Rheinl. Jahrg. XXX, 4. Folge, X Bd.
70. Strömfelt, H. F. G., Om Algevegetationen vid Islands kuster. Göteborgs Kgl. Vetenskaps och Vitterhets Samhälles Handlingar. Göteborg, 1887.
71. Svedelius, Nils, Studier öfver Östersjöns hafsalg-flora. Upsala, 1901.
72. Warming, Eug., Oecology of Plants. Oxford, 1909.
73. Wille, N., Studien über Chlorophyceen, I-VII. Vidensk. Selsk. Skr. I. Mathem. naturvidensk. Klasse, 1900, Nr. 6. Kristiania, 1901.
74. — Bidrag til Algernes physiologiske Anatomi. Kgl. Sv. Vet. Akad. Hdl. Bd. 21. Stockholm, 1885.
75. — Om Fucaceernes Blærer. Bih. till Kgl. Sv. Vet. Akad. Hdl. Bd. 14, Afd. III, No 4. Stockholm, 1889.
76. Wittrock, V. B., Försök till en monografi af algsläktet Monostroma. Stockholm, 1866.
77. Ørsted, A. S., De regionibus marinis. Elementa topographiæ historico-naturalis freti Øresund. Hauniæ, 1844.

ERRATA.

P. 3, line 6, for of read off.

P. 29, line 15, for Kylin (43) read Kylin (45).

2.

AN ACCOUNT

OF

THE PHYSICAL GEOGRAPHY
OF ICELAND

WITH SPECIAL REFERENCE TO THE PLANT LIFE

BY

TH. THORODDSEN

PROFESSOR, PH. D.

WITH 36 FIGURES IN THE TEXT

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I. GENERAL TOPOGRAPHY. GEOLOGY.

ICELAND is a large island in the North Atlantic. It stretches from $63\frac{1}{2}^{\circ}$ to $66\frac{1}{2}^{\circ}$ N. lat. and from $13^{\circ} 27'$ to $24^{\circ} 30'$ W. long. fr. Gr.; consequently, the Arctic Circle touches its northernmost points, and as a result, along the northern coast, the midnight sun turns night into day for a short time during summer. In the most northerly districts the sun is above the horizon for a week; at Reykjavík the longest day is 20 hours 56 minutes, the shortest 3 hours 58 minutes. The distances from Iceland to the neighbouring countries are as follows: — to Norway 950 km., to Scotland 900 km., to the Færøes 450 km., to the east coast of Greenland 330 km., and to Denmark 1500 km. The length of the island from east to west is 490 km., and the breadth from north to south is 312 km. Its area is about 104,000 sq. km.

Iceland is a very mountainous country although it has not any true mountain-chains; it is most properly described as a continuous table-land with an average height of 700—1000 metres above sea-level; besides, there are only narrow borders of coastal land, valleys which cut into the table-land from all sides, and a few small areas of level land towards the south and west. Scarcely one-fifteenth of the country can be reckoned as lowland. Owing to its northern situation, its height above sea-level, and the resulting severe climate, only a relatively small part of the country is inhabitable. More than two-thirds of the entire area of the country is situated at so great a height above sea-level that almost no vegetation can thrive there. The sandy and stony deserts of the interior plateau, the lava tracts, and the glaciers are not fit dwelling places for human beings: therefore it is almost exclusively the coasts and the valleys which are inhabited.

The coast of Iceland is upon three of its sides indented by fjords and bays, while the south coast is almost wanting in indentations — fjords, harbours, etc.; the coast-line is best developed towards the north-west, where a peninsula with many fjords projects from the main land. The coast-line of Iceland is about 6000 km. in length, of which one-third belongs to the north-western peninsula. The indentations of the coast may be divided, according to their origin and size, into two groups, the large bays which are probably formed by the sinking of the earth's crust, and the fjords proper which appear to owe their origin chiefly to erosion. Along the south coast the great Jökulls (snowfields) descend toward the sea and the masses of gravel carried down from the glaciers have, in the course of time, filled up all the fjords, causing the sea outside the fjords to be so shallow that it is dangerous for vessels to approach the coast. The breakers throw up bars of coarse shingle which dam the waters of the numerous glacier-rivers, and so shoals and shifting lagoons are common along this coast; the largest of them are to be found towards the south-east (Alftafjörður, Papos and Hornafjörður). In the western part of the south coast the fjords and bays of olden times have been filled up not only with the sediments of glacier-rivers, but also with great lava-streams. From the west two large bays, Faxafjörður and Breiðifjörður, extend inwards, they are separated by the mountainous and volcanic Snæfellsnes. The former of these bays is 68 km. in length and 90 km. in breadth, the latter 124 km. in length and 74 km. in breadth; from them several small fjords extend inwards, especially from Breiðifjörður, which at its head divides into two large arms, Gilsfjörður and Hvammsfjörður. The north-western peninsula (Vestfirðir), as mentioned above, is indented by numerous fjords, and there are several excellent harbours, trading-stations and fishing villages in those fjords which turn their mouths towards the north-west; of these fjords the largest are Arnarfjörður and Isafjardardjup, both of which have many branch-fjords. On the north coast there are also many large indentations which are separated by mountainous peninsulas; of these bays and fjords the following are the largest, proceeding from west to east: Húnaflói, Skagafjörður, Eyjafjörður, Skjálfandi, Axarfjörður and Thistilfjörður; and from these larger bays several smaller fjords extend further into the country. Of the peninsulas the following may be mentioned: Skagi, Tjörnes, Melrakkasletta and Langanes; the two large peninsulas on either side of Eyjafjörður have no distinctive

names. In East Iceland there are also many larger and smaller bays and fjords; the largest and best-known are Vopnafjörður, Hjeradsflói, Seyðisfjörður, Reyðarfjörður and Berufjörður. Although the coast of Iceland is so cut up by fjords, it is not especially rich in islands; only in Breiðfjörður is there a number of islands and islets, in two large groups or collections; otherwise, the islands along the coast of Iceland are few and scattered, and are usually high and rocky. To the SSW. of Iceland are situated the volcanic islands, the Vestmannaeyjar and Fuglasker, and north of Iceland, in the Arctic Ocean, the Isle of Grímsey, 45 km. from the coast.

The north, east and north-west coasts of Iceland, which abound in fjords, are everywhere rocky, and rise steeply from the sea like black walls 300—500 metres in height, composed of from 30 to 100 layers of basalt, distinguishable as narrow ledges or steps. Numerous small streams have excavated channels in the rock-sides, and leap in small cascades from ledge to ledge. The foot of the mountain and the narrow coastal-land are usually green and grassy in places where the rocks are not too steep, but the mountain itself is chiefly of dark rocks, covered with gravel, and with white patches of snow in the higher regions. At the head of the fjords, whence the various valleys branch off into the interior of the country, there usually occur several or a few groups of mountains with crests, ridges and peaks often of the most fantastic form, while the edge of the mountains along the fjords resembles walls with bastions and battlements. At many of the fjords there are trading-stations with the wooden houses painted white or red, while scattered under the sides of the mountains the white gables of the farm-houses peep forth amidst the sap-green home-fields. On the south coast the mountains retreat and the strand is bounded by sandy and pebbly flats; along these tracts the mountains are usually more rounded and softer in outline, as they are composed of tuff and breccia. The highest parts of the plateau are covered by snow-fields (Vatnajökull, Myrdalsjökull) from which large and small glaciers come down through every cleft, and extend to the level country.

Iceland consists of two distinct table-lands, one large (about 88000 square km.) and one much smaller (about 9000 square km.), the north-western peninsula, which is attached to the mainland by a narrow neck of land only, forming a table-land by itself. The large table-land which almost entirely occupies the remaining part of the island is highest towards the SE. where the snow-masses of

Vatnajökull cover an area of about 8000 square km. The axis of elevation lies from NW. to SE., from somewhere near the head of Hvammsfjörður to Hornafjörður; it does not, however, consist of one continuous ridge, but of a series of snow-covered, dome-shaped mountains separated by broad stretches of more level ground. These snow- and ice-covered domes are strictly speaking a series of small plateaus which rise from the main plateau to an absolute height of 1400–2000 metres, as compared with 600–1000 metres above the plateau. The most easterly of the great glacier-bearing mountains is Vatnajökull which is separated from the much smaller Tungnafellsjökull (100 square km.) by Vonarskarð (1000 metres); between Tungnafellsjökull and Hofsjökull (1350 square km.) lies the broad stretch of level ground, Sprengisandur (650 metres); west of Hofsjökull and between the latter and Langjökull (1300 square km.) lies Kjölur or Kjalvegur (600 metres); and between Langjökull and Eiríksjökull (100 square km.), Flosaskarð (800 metres). The plateau north of the last-mentioned ice-mountains abound in lakes and bogs. The interior plateau consists chiefly of deserts almost destitute of vegetation, but the surface varies somewhat in character in accordance with the geological nature of the underlying rock. Where basalt or dolerite forms the substratum, the surface is strewn with innumerable angular blocks of rock, split asunder by the action of frost; where tuff and breccia form the foundation, the surface is usually covered with gravel and fragments of slaggy lava which have been loosened from the breccia by the action of weathering. More than one-half of the plateau is overlain by more recent formations — lava, blown sand, volcanic ashes, glacial formations, clay and river-gravel. The lava-fields, taken together, cover a very large area in the interior and present a most desolate scene; as far as the eye can reach only a black, hardened mass is seen, and the dark colours are only here and there interrupted by mounds of reddish slag, smoking craters, scattered snow-drifts, and in the distance by glistening, white Jökull-domes; there is no sign of life and an oppressive silence reigns over the land.

The interior plateau is trenched by many valleys, chiefly towards the north and east; between these valleys long mountain spurs — the skeletal ribs of the eroded plateau — branch outwards toward the sea. Of these, the mountain-mass which extends towards the south, and is crowned at the top by Myrdalsjökull, is the most considerable. Towards the west the two volcanic mountain-chains

extend outward upon Reykjanes and Snæfellsnes. The mountain-chain on Reykjanes is broad and flat at the top; it is divided into several smaller plateaus (300—600 metres) with rows of craters and volcanic mountain-tops, and it sinks down more and more towards the west so that the extreme end of the peninsula consists chiefly of low-lying lava-fields with a few low, isolated mountain-tops. The mountain-chain which extends toward Snæfellsnes is higher (600—900 metres), but much narrower; it is also very vol-

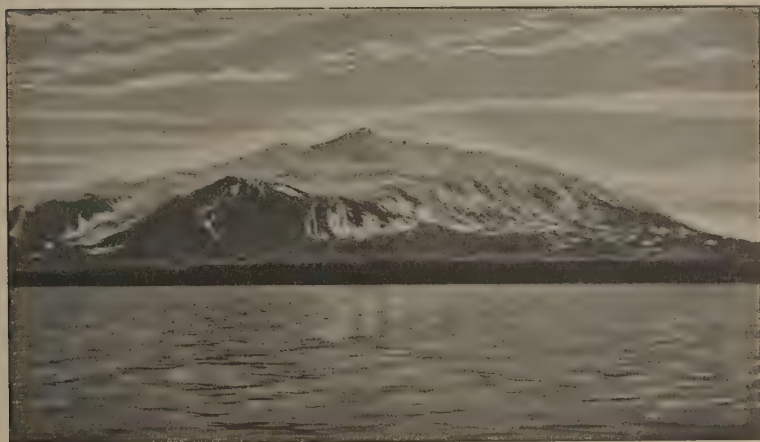


Fig. 1. Snæfellsjökull (West Iceland).

canic and terminates in the ancient, ice-capped volcano, Snæfellsjökull (1446 metres).

In North Iceland several great mountain-masses proceed from the high land outward upon the peninsulas, and from the head of the fjords long valleys extend into the country; by the extensive branching of the valleys, the mountains are divided into a number of ridges and peaks, which however when examined more closely, prove to have been cut out of an originally continuous plateau. Several valleys lead up from Húnaflói, of which the western are narrow, but the eastern (Víðidalur, Vatnsdalur, Blöndudalur) are broader and more fertile; these latter open out toward the low land (Thing) at the head of Húnaflói. The large peninsula between Skagafjörður and Eyjafjörður is occupied by mighty, steep mountain-masses which are intersected on both sides by numerous valleys, the largest (Öxnadalur, Hörgárdalur, Svarfaðardalur) being on the

east. On this peninsula occur the greatest heights in northern Iceland (Vindheimajökull, 1445 metres; Kerling 1350 metres; Rimar, 1261 metres). Broad, fertile and thickly-inhabited main valleys stretch up from the head of Skagafjörður and Eyjafjörður; east of Eyjafjörður, between the latter and Skjalfandi, the stern, wild mountains rise to a height of 1200 metres, and there Fnjóskadalur, which cuts through these mountains towards Eyjafjörður from the east, opens out. These mountains fall abruptly towards the east down towards Bárðardalur (70 km. long), but east of that valley the country becomes lower, and has a different geological structure and character; hitherto, basalt has been the dominant rock, but hereafter, for a long distance, the substratum is formed of tuff, breccia and recent volcanic formations. East of Bárðardalur the plateau gradually sinks down towards the sea, and inhabited spots occur, not only along the coast and in the valleys, but also here and there upon the high land itself (Myvatnssveit, 300 metres above the level of the sea; Fjallasveit, 450—500 metres). Upon these areas of the plateau there are many isolated mountains and mountain-ridges, volcanoes and lava-streams.

The eastern part of Iceland is called collectively Austfirðir. There the country is very mountainous towards the coast and indented by deep fjords which are bounded by high, precipitous rock-walls, basalt being now again the dominant rock. From Hjeradsflói two long valleys, 80—90 km. in length, extend towards the south. These valleys, which unite lower down, are called Jökuldalur and Fljótsdalshjarað; the latter lies behind the fjord district of eastern Iceland and cuts it off from the interior plateau which is here somewhat lower than the coastal mountains, which reach a height of 10—1100 metres and even more. Towards the south there are two smaller Jökulls, Thrandarjökull and Hofsjökull í Lóni, with an area of 100 and of 80 square km. and a height of 1100—1200 metres respectively. Near Hornafjörður the character of the coastal land changes completely, because there the plateau, to its extreme edge, is buried beneath the snow and ice-fields of Vatnajökull. The low, narrow and sandy coastal border is irrigated by glacier-water streaming down from the numerous glaciers which advance through every cleft and valley. Here and there, along the edge of the snow-field, mountains and rocky promontories appear, and of the former the imposing volcano of Öræfajökull (2119 metres), Iceland's highest mountain, is the most noticeable; other promontories and mountains near the southern edge of Vatnajökull have a height of 1100—1500 metres.

North of the mountain of Lómagnupur (770 metres), which is a breccia-promontory rising steeply from a sandy flat, the glaciers recede from the coast and the plateau is continued as a low hilly edge as far as Mýrdalsjökull, the snow-masses of which cover the upper part of the above-mentioned southern spur of high land and which has an area of about 1000 square km., reaching a height of 1666 metres in the volcano of Eyjafjallajökull. Another very active and dangerous volcano, Katla, also hides itself beneath the glaciers of Mýrdalsjökull. West of this snow-field the plateau retires again from the coast; the deep valley of Markarfljót separates Mýrdalsjökull from Tindfjallajökull (1462 metres), and north of the latter lies the oblong, volcanic Torfajökull (1400 metres) and the famous volcano Hekla (1447 metres). North-west of Hekla and near Geysir, the plateau retires to its greatest distance from the coast (about 80 km.), but bends thence again towards the south-west, outwards towards the peninsula of Reykjanes.

The lowlands of Iceland cover only a small area; in the north and east there is no low land with the exception of the larger valley-mouths, e. g. at the head of Húnaflói, Skjálfandi and Fljótsdals-hjerað and the extreme end of the peninsulas of Skagi and Mel-rakkasljetta. Larger lowland areas occur only in South and West Iceland; they are however small in extent compared with the mountainous country and the table-lands. Although the lowlands only comprise one-fifteenth of the entire area of the country, yet together with the valleys they are of very great importance because tolerably favourable climatic conditions and a closer vegetation, permitting fixed habitations and the rearing of cattle, are found almost exclusively there; the inhabitants of the few dwellings which occur scattered in the lower parts of the plateau must struggle with severe conditions and are almost entirely reduced to sheep-rearing alone. But by no means all the lowlands are grass-covered; large tracts of lava, glacier-gravel and blown sand are extremely poor in plant-life. On the south coast the country nearest to the sea is quite flat, from Hornafjörður to Reykjanes, but in many places this level land is so narrow that it consists only of an insignificant coastal border; in other places it widens out into larger plains and extends further into the country. Between Hornafjörður and Mýrdalsjökull, below Vatnajökull, the coastal country is formed by deposits from the numerous glacier-rivers and consists exclusively of sand and gravel; the lowland here is often flooded by branching torrential glacier-

rivers, so that no vegetation can thrive here. Below the southern edge of Vatnajökull the farmsteads are therefore confined to oases separated from one another by gravel-deserts and swollen glacier-rivers. In many places the people have been obliged to move their houses up on the mountain sides in order to avoid inundations caused by the glacier-waters, and here the mountain-sides facing south are covered with a luxuriant plant-growth, while the level country below is devoid of vegetation. The sandy tracts have different names, such as Breiðamersandur, Skeiðarársandur, Brunasandur, Mýrdalssandur, Sólheimasandur, etc. Of these the largest is Skeiðarársandur (about 900 square km.), and taken together they cover an area of about 2700 square km. Between Lómagnupur and Mýrdalsjökull the lowland becomes broader and is covered by extensive lava-fields, blown sand, gravel and volcanic ashes, as large volcanoes occur in the neighbourhood. The largest area of low land in Iceland lies between Eyjafjallajökull and the peninsula of Reykjanes and is about 4000 square km. in extent; it is hemmed in by tuff-mountains which in many places fall abruptly towards the plain. The lowest part of the lowland is only slightly raised above sea-level, but it rises gradually towards the interior where it ultimately branches off into different valleys; near Geysir it reaches its greatest height above sea-level, about 150 metres. The low land is not flat everywhere, some parts of it are hilly, and a few isolated mountains also rise from the plain. West of Hekla the lowland, by means of a gentle rise, is in direct connection with the interior plateau, to the great danger of the inhabited districts, as the blown sand, volcanic ashes and pumice dust which cover large areas of the interior have thereby free access to the lowlands; therefore, in these regions, during north-westerly storms, large tracts of grass-covered and inhabited land have been overwhelmed in the course of time. The lowlands consist chiefly of grassland, and nowhere in Iceland do farmsteads occur so closely together as here, these districts being well-suited to cattle-rearing. Three very well-supplied rivers run through the lowland, viz. Markarfljót with a large delta-land (Landeyjar), Thjórsá and Ölfusá, and besides these there are many smaller ones. The eastern part east of Thjórsá is called Rangárvallasýsla, the western Árnessýsla. At the head of Faxaflói there is another low area (about 1000 square km.) which on an average has a height of only 20—30 metres. It is bounded by steep, basalt mountains which are arranged in a semicircle around

the lowland which is very swampy and above which project numerous low, isolated, basalt hills. The eastern part is called Borgarfjörður and the western Mýrar. From the low land several wide valleys extend inwards between the mountains.

The north-western peninsula, as mentioned above, constitutes a small plateau by itself and is separated from the mainland by Breiðfjörður and Húnaflói; the isthmus which connects the peninsula with the mainland has a breadth of only 7 km., and rises to a height of 228 metres. The coast of north-west Iceland, which is much indented by fjords, is bounded everywhere by steep, dark mountain-sides which often rise abruptly, even vertically, from the sea to a height of 400—500 metres. The mountains are everywhere composed of horizontal, or slightly inclined, basalt-layers which are highly denuded by erosion, so that numerous small valleys, cirques, clefts, ridges and bastions occur as in other basalt regions of Iceland. By climbing the mountain-edge up in the highlands, and ascending to a sufficient height it will be seen that fjords and valleys have trenched the plateau with great regularity. The eye wanders freely over wide wastes, the valleys and fjords either disappear or are seen as insignificant clefts, and a monotonous table-land lies stretched out to view, the surface of which is broken only by low ranges of hills, and ice-striated basalt-masses with large stretches covered by angular blocks of rock and scattered snow-wreaths. It is often extremely difficult to traverse this kind of ground, across an ocean of rocky blocks, where the clay and the gravel between the blocks often occur as a slushy mass owing to the thawing of the numerous patches of snow. Only now and then can a solitary, stunted Alpine plant be seen maintaining a miserable existence in the shelter of the large blocks of rock. The plateau of the north-western peninsula has an average height of only about 600 metres, and where it is highest (800--900 metres) the snow drifts and consolidates into *névé*-domes — Gláma (about 60 square km.) towards the SW. and Drangajökull (about 350 square km.) towards the NE. The numerous valleys which lead up from the fjords and cut into this plateau are similar in character to the other Icelandic valleys in the basalt districts, so it will be convenient to describe their physiographical characters collectively. The bottom of the valley rises gradually in broad rock-terraces, upon the surface of which bogs and small lakes often occur, and it terminates amphitheatrically in a large cirque, down the steep rocky sides of which several streams fall in cascades.

The mouths of the contributory valleys are often situated at a higher level than the bottom of the main valley and along the mountain-sides a series of cirques are often found. Hundreds of streams carry gravel and rock-fragments down to the foot of the mountain and to the valley, and below each notch in the mountain there is, therefore, a flat cone of gravel which extends down the side of the mountain to the bottom of the valley; each little cirque and each notch has, like an hour-glass, according to the law of gravitation, emptied its contents upon the level land below. The foot of the mountain is covered with plants, but any aggregate of vegetation has rarely been able to extend higher than half-way up the mountain-side; only on ridges between clefts and hollows, where neither floods, rock-slips nor avalanches can do harm can the plant-covering extend upwards in longer tongues, while the upper half of the mountain-side consists but rarely of anything except bare rock-ledges or rock-faces or heaps of stones. On a closer investigation, a few individual plants will however be found seeking cover, shelter and foothold among the blocks of rock and in the crevices. In places where springs are trickling out in a row from between rock-strata there is often a luxuriant vegetation of yellowish-green mosses which form soil and pave the way for the higher plants. Even on the most precipitous valley-sides, sheep are seen scattered about seeking the mountain-plants which peep forth between the stones. Upon the north-western peninsula there are no lowlands, but only a narrow border of coastal land which is due to the action of the breakers at a time when the sea-level was higher than at present. Only the narrow coastal land along the sides of the fjords is inhabited, and the inhabitants are chiefly dependent upon the sea for subsistence. Where the land which fringes the coast becomes somewhat broader and the valleys more grassy, as along the north coast of Breiðifjörður, the inhabitants' chief means of sustenance is sheep-rearing; where the fjords are small, the mountains steep, and the coastal land has disappeared, as along the coast south of Cape Nord, the inhabitants maintain themselves almost entirely by the catching of birds upon the steep sea-cliffs.

Glaciers. The snow- and ice-covered mountains (Jökull)¹ of Iceland, taken together, cover an area of 12700 square km. and

¹ In Iceland, by "Jökull" a glacier-bearing mountain is usually meant, but sometimes the term is used for the masses of snow and *névé* upon the mountain.

through their glaciers and glacier-rivers they exert a great influence upon the surface and climate of the country and upon the conditions of life of the inhabitants. The Icelandic climate is specially adapted to the development of large glaciers, for the air is raw and cold and moist, the amount of rainfall considerable and the summer-heat slight. The amount of precipitation is greatest towards the south-east and there the interior table-land is covered by the great Vatnajökull. The altitude of the snow-line varies from 400 to 1400 metres in the different parts of the country, and the level above the sea at which the glaciers end differs greatly; in the north on the north-western peninsula, and in the south near Vatnajökull, the glaciers descend almost to the sea, to 25 metres and 9 metres above sea-level respectively at the lowest points to which they descend. The great ice-mountains of Iceland are without exception closely associated with the plateau. Large areas of the highest part of the plateau are covered with *névé* which occurs as slightly-arching domes or undulating snow-fields of great thickness. Prominent mountain-peaks are rare; the latter do not appear until near the edges of the snow-fields and usually as outstanding summits of the underlying rock. The surface of these snow-fields is devoid of gravel; this does not appear until it does so at the extremities of the glaciers which are often quite black with it and with sand and blocks of rock. The large glaciers which descend from these *névé*-covered flats have, on an average, a very slight declivity; only in places where precipitous mountain-peaks project from the edge of the snow-field, do steep glaciers of small dimensions occur. The large glaciers of Iceland closely resemble the glaciers typical of Arctic countries; but there are a great many small glaciers which resemble those of the Alps. Several of the broad glaciers which descend from Vatnajökull cover a very considerable area (e. g. Dyngjujökull 400 square km., Bruarjökull 500 square km., etc.). Peculiar to Iceland are the so-called "glacier-torrents" (*Jökul-hlaup*). When the glaciers, by the eruption of volcanoes hidden under the ice, are broken to pieces and melt, the large stretches of land beneath them are inundated by a roaring sea of dirty water with swirling icebergs. Such catastrophes may cause great changes in the surface-features of the surrounding country, as the waterfloods often carry along with them an incredible quantity of gravel and rocky blocks. In this way the volcano of Katla especially has caused considerable changes — the course of rivers are constantly changed, the smaller

fjords have been filled up even within historic times, and several large parishes and districts have been destroyed. Örafajökull has, in the same manner, caused considerable destruction; while the waterfloods of Skeiðarárjökull, which were especially frequent during the 19th century, have done less material damage, as only uninhabited sandy wastes were inundated. Minor glacier-bursts are also occasionally due to lakes and rivers, which have been dammed by glaciers, suddenly breaking through their barriers and inundating the district. These glacier-bursts have a great effect upon the plant-life, because no permanent vegetation can exist upon gravelly and sandy flats which are constantly inundated by waterfloods carrying large pieces of ice; therefore very large stretches of lowland in the neighbourhood of such volcanoes and glaciers are destitute of plant-growth, for what little vegetation appears in the period between the glacier-bursts is quickly destroyed. The general physiographical conditions pertaining to the glaciers of Iceland may be best seen by a study of the table opposite.¹

Snow-line. In Iceland it is not easy to determine the snow-line, owing to the great variability of the climatic factors. Because of the great annual and periodical variability of temperature and of the circumstances connected with precipitation, the snow-line also varies. In Iceland three kinds of height-levels connected with the vertical distribution of the snow, and dependent on climatological and orographical conditions, may be supposed to exist. The snow-line proper, which signifies the lowest limit of the permanent, continuous snow-covering of the mountains, is not subject to very great changes from year to year. Below this comes a zone of detached, more or less closely placed, patches of *névé* and wreaths of snow; these never melt entirely, but either are added to or else diminish according to the character of the year. Below this zone comes the most variable of the snow-coverings: scattered snow-drifts which to a greater extent than the others are dependent on orographical conditions. These snow-drifts may persist through a series of damp and cold years, but dwindle almost to nothing or disappear entirely in warm and dry years. The snow at Drangajökull upon the north-western peninsula may serve as an example. Here, on

¹ Here it should be noticed that many of the figures for the area of the Jökulls are approximate and given as a rough estimate, because the maps of a great part of Iceland, and especially of the plateau are still very imperfect.

Names of Jökulls	Approximate area in sq. km.	Greatest height above sea-level in metres	Altitude of snow-line in metres	Number of glaciers known	Altitude of inferior end of glacier in metres
Gláma.....	cir. 60	901	cir. 650	—	—
Drangajökull.....	350	890	—	7	—
— east side.....	—	—	400	—	30
— west side.....	—	—	650	—	25
Snæfellsjökull....	23	1446	—	2	560
— north-east side..	—	—	650	—	—
— south-west side..	—	—	1000	—	—
Langjökull.....	1300	1400	—	31	—
— south-west side..	—	—	900	—	600
— east side.....	—	—	1000	—	435
— north-west side !..	—	—	1000	—	628
— north side.....	—	—	1100	—	—
Eiríksjökull.....	100	1798	—	6	606
Ok.....	15	1198	900-1120	—	—
Hlöðufell.....	1	1188	960	—	—
Arnarfellsjökull (Hofsjökull) ..	1350	1700	—	19	—
— east side.....	—	—	—	—	552
— north side.....	—	—	1200	—	910
Mýrdalsjökull.....	1000	1666	—	20	—
— north side.....	—	—	1100	—	700
— south side.....	—	—	8-900	—	97
— east side.....	—	—	6-700	—	205
— west side.....	—	—	1000	—	220
Torfajökull.....	100	1200	950	—	—
Tindfjallajökull.....	22	1462	950-1000	5	570
Vatnajökull.....	8000	2119	—	41	—
— west side.....	—	—	1000	—	635
— south side.....	—	—	900	—	9
— north side.....	—	—	1300	—	600
— east side.....	—	—	950	—	700
Hofsjökull í Lóni	80	1200	850-950	1	—
Thrandarjökull.....	100	1200	900	—	—
Snæfell.....	15	1822	—	2	—
Tungnafellsjökull.....	70	1600	1300	2	—
Dyrfjöll.....	5	1131	600	—	—
Fönn.....	10	900	—	—	—
Kaldbakur.....	5	1161	—	—	—
Vindheimajökull.....	10	1466	—	1	—
Myrkárjökull.....	10	1200	—	1	—
Túnahryggsjökull..	40	1200	—	4	—
Unadalsjökull.....	20	1200	—	—	—
	12686	—	—	142	—

the eastern side the snow-line stands at a height of 400 metres above sea-level, on the western side at an altitude of 650 metres. Upon the plateau itself, around the base of Drangajökull, there are numerous large, scattered wreaths of snow which taken collectively would cover a large area; they occur at an altitude of 250—500 metres. In the summer of 1886—87 there occurred, in addition, numerous wreaths at a lower level — in sheltered places even close to the sea-shore, especially at Snæfjallaströnd, where very long snow-drifts were lying on the terraces of the basalt beds. In these districts old banks of snow are usually very frequent at a height of 50—100 metres above sea-level; the climate also is very raw and the precipitation considerable; there are occasional snow-storms in the middle of summer, and drift-ice with cold, damp fogs and drizzling rain is a frequent visitor. The sea cuts into the land from all sides.

Above the snow-line proper there is naturally no vegetation, with the exception of a few individuals which maintain their existence on projecting rocks and “Nunataks” in the ice. In the region of permanent snow-drifts there occurs, only here and there, a poor and very scattered rocky-flat vegetation, but in the zone of the variable snow-drifts there may often be a vegetation of different species which is rather luxuriant, considering all things. According to my measurements in the years 1882—1898 the snow-limits were about as follows (the snow-limits given in the table on p. 203 may serve for comparison): —

	Snow-limit in metres	Lowest limit of the permanent snow-drifts in metres	Lowest limit of the variable snow-drifts in metres
Northern part of the north-western peninsula	400-650	250-500	50-100
Snæfellsnes	800-1000	cir. 700	500-600
Ódáðahraun	1400	1000	—
Mývatn	—	700-800	—
Peninsula NE. of Eyjafjörður	1000	450-500	200
Austfirðir	900-1000	500-550	300-400
Plateau between Vatnajökull and Mýrdalsjökull	1100	600-700	—
Arnarvatnsheiði NE. of Langjökull	1000-1100	600-700	500-600
The neighbourhood of the southern lowland	1000-1100	800-900	—

Rivers. Iceland possesses numerous rivers of considerable size; their volume is due to the damp climate of the land and to the great number of glaciers. The Jökulls serve as huge water-reservoirs, from which the majority of the larger rivers are supplied, and the glacier-plateaus also attract rain and other atmospheric precipitation, so that the supply is always uniform. The volume of water is greatest in the lower-lying districts because the plateau above 500—600 metres, to a great extent, is covered with lava, gravel and loose sand which absorb all the moisture; but it reappears further down, and below the 500 metre line there are extensive bogs both in the lowest part of the plateau, in the lowlands and in the valleys. In the lava-deserts both on the plateau and in the lowlands, the rain and melted snow disappear immediately, and large tracts are quite destitute of water; but at the edge of the lava numerous springs bubble forth from the earth. The water which at first is usually turbid and intermingled with glacier-mud, becomes filtered by passing through the lava, and is therefore very pure and clear in the springs. When there is no outlet, water is sometimes found in the lava-field itself, at the bottom of deep clefts; as for instance, the renowned, cold, crystal-clear water in the lava-clefts near Thingvellir. In early summer, during sudden thaw, while the frost-layer still persists in the ground, extensive gravelly and clayey flats on the plateau and in the lowlands are turned into morasses, but when the ice of the subsoil melts later in the summer outlets are again opened for the surface-water so that the gravel-fields are drained. In the valleys numerous springs make their way through the basalt along the mountain-sides, often in long rows between the layers, and can be detected by the green mosses which grow luxuriantly around them.

Icelanders draw a distinction between “bergvatn” (mountain-water) which is clear, and “jökulvatn” (milky-white glacier-water) which may have a muddy, yellowish colour or a chocolate-brown colour according to the amount and kind of glacier-clay carried in it. The amount of clay in the glacier-water is larger in summer than in winter and, again, the glacier-rivers are clearer and of less volume in the morning than later in the day. Differences in the weather — cold or warm or wet or dry years — have the greatest influence as regards the volume of water in the glacier-rivers. In dry and warm summers the clear rivers are but small, while the water carried by the glacier-rivers increases to double or three times the usual volume. As the glacier-rivers are so dependent upon the

melting of the snow their size varies from day to day and from year to year; many glacier-streams which disappear entirely during winter, carry in warm summers an immense volume of water. Almost all Icelandic glaciers rest on soft rocks (tuff and breccia) upon which erosive action is very active; therefore, the Icelandic glacier-rivers carry down an immense amount of rock in the form of mud, sand, gravel and blocks of stone; for this reason they are hardly ever found entering fjords or deep bays, these having quickly become filled up in cases where they formerly so entered, while the Jökulls (glacier-bearing mountains) are surrounded by large sandy and gravelly tracts which for the most part owe their origin to the rivers.

Taking the whole of the island into account, rivers containing glacier-water are decidedly in the majority. South of Vatnajökull clear water is almost unknown, as all rivers and brooks originate in the glaciers. There all the rivers flow down to the coast by short courses in torrential current, and during summer some of them are so broad that it takes hours to cross them — but then it must be remembered that it is necessary, in the middle of the river, to go a long way round, on account of the current and depth. On the flat, sandy tracts the rivers are constantly changing their course, and greater and smaller changes take place daily. All glacier-rivers branch abundantly.

In accordance with the slope of the land, the longest and largest rivers flow in South Iceland towards the south-west and south, and in North Iceland towards the north; the majority of them rise on the plateau at a height of 600—900 metres above sea-level, a fact which should be correlated with the limits of the glaciers in the interior. Although the Icelandic rivers carry a comparatively great volume of water yet they are not navigable, because of their usually steep fall, their torrential current, and their tendency to spread out and subdivide into numerous branches in the low land. The largest rivers of Iceland are as follows: — From the south edge of Vatnajökull rise Jökulsá í Lóni, Hornafjarðarfljót, Jökulsá á Breiðamerkursandi, Skeiðará and Núpsvötn; the last three are considered to be the most dangerous glacier-rivers of Iceland. From the west edge of Vatnajökull rise Hverfisfljót, Skaftá and the well-supplied Kúðsfljót; this last also receives a large supply of water from Mýrdalsjökull. From the latter another river flows down — the short, but torrential Jökulsá á Sólheimasandi, also called

Fúlilækur, which often has minor "glacier-torrents" that carry down ice-pieces and stones. On the east side of the southern lowlands, Markarfljót flows into the sea; it rises in Torfajökull, but also receives well-supplied feeders from Mýrdalsjökull; in the low land it divides into four arms which enclose the largest delta-land of Iceland, the so-called Landeyjar. Thjórsá, Iceland's longest river

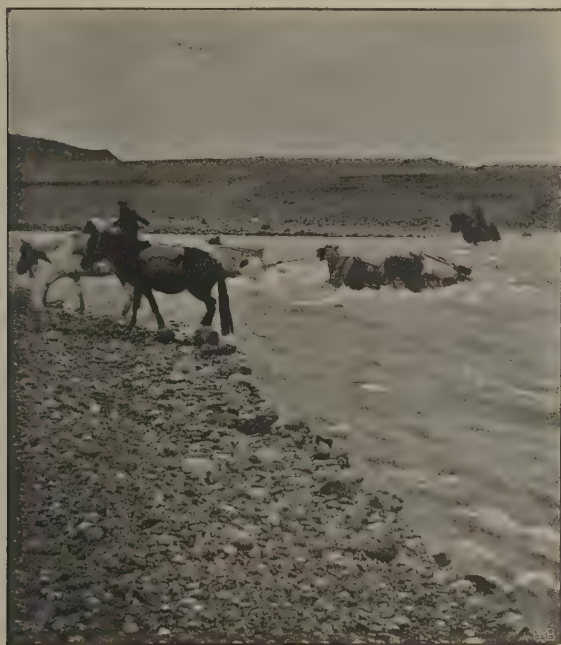


Fig. 2. The river Jökulsá á Sólheimasandi. A ford.

(200 km.) rises in Arnarfellsjökull, but receives about one-half of its water supply from Vatnajökull through its tributary Tungná; Thjórsá carries an immense volume of water and, in the cultivated district, is in several places one km. or more broad; above its mouth it forms an expansion or a saccate lagoon and is joined by a well-supplied arm of Markarfljót, named Thverá. The third and most westerly large river in the southern lowlands is Ölfusá which, for the longest part of its course (until the mouth of the tributary river Sog), flows under the name of Hvítá and issues from Hvítarvatn near Langjökull receiving, both on the plateau and in the cultivated district, many large affluents from both sides. In the neighbourhood

of Geysir, Hvítá forms the large waterfall Gullfoss. Towards the west, another river named Hvítá flows down through the district of Borgarfjörður; it carries a great volume of water and its lower course is navigable. In the north-western peninsula there are no large rivers, but in North Iceland many such occur, among others Blanda, which issues from Arnarfellsjökull and flows into Húnaflói. From the same Jökull issues also Hjeraðsvötn which flows through the district of Skagafjörður and empties itself into the fjord by two

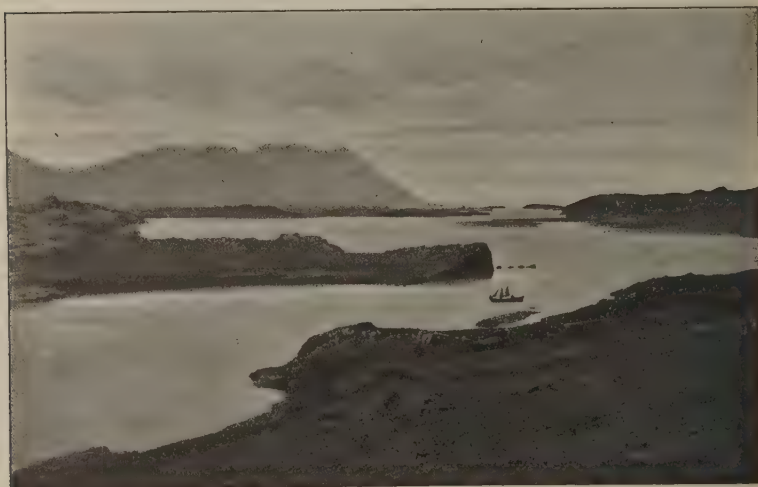


Fig. 3. The river Hvítá flowing through the district of Borgarfjörður.

mouths. Three rivers of rather large volume — Hörgá, Eyjafjarðará and Fnjóská — enter Eyjafjörður. Then there is Skjálfandafljót which issues from Tungnafellsjökull and flows through the Bárdardalur; it has many waterfalls, among which Godafoss is the best-known. Jökulsá á Fjöllum, one of the best-supplied rivers of Iceland, empties into Axarfjörður and in its lower course falls through a deep cleft and forms Iceland's grandest waterfall, Dettifoss. In East Iceland two large rivers are noticeable, Jökulsá á Brú and Lagarfljót, both of which issue by many arms from the north edge of Vatnajökull and fall into Hjeraðsflói, after the latter river has expanded into a deep, oblong lake. Besides the numerous cataracts in the large rivers, there are also beautiful cascades (Fossar) in the smaller streams; of these the better-known are Hengifoss in Fljótsdalshjerad, Glymur in Botnsdalur, Dynjandi in Arnarfjörður in the north-western pen-

insula, and Skogafoss and Seljalandsfoss below Eyjafjallajökull. These cascades have a height of about 100 metres and more. The largest rivers, only, have been mentioned above, but in addition to these, hundreds of streams of greater or lesser volume occur, often with beautiful waterfalls and cascades in connection with picturesque clefts and rocks.

As mentioned above, the torrential and changeable glacier-rivers have a destructive influence upon the cultivation and vegetation of the plains. The greensward is torn off and large areas are covered by gravel, therefore the level country south of Vatnajökull is in several places turned into a desert almost destitute of vegetation except where special natural conditions afford a shelter from the destructive effect of the rivers. Where the action of the glacier-rivers is suddenly arrested by any natural phenomenon the level country again becomes quickly covered with plants. As an example may be mentioned the fact that Hverfisfljót, in the year 1783, was forced out of its bed by a great lava-stream, and a considerable stretch of land — Brunasandur — which had previously been irrigated by cold and torrential river-branches was freed from these, only a few clear streams of filtered glacier-water with a slight current issuing from the edge of the lava-streams and flowing down the level country; so that where in 1783 there was a gravelly and sandy flat without plant-life and without means of sustenance for human beings there is now a parish with seven farmsteads and abundance of meadows and pasture-lands for the sheep and cattle of the inhabitants. In itself the glacier-water is not inimical to vegetation; it is only the torrential current, the changeableness of the water-courses, and the low temperature of the water which have a destructive effect upon plant-growth; where these factors are not active, the glacier-water, with its contents of fine clay, is on the contrary a fertilizer; therefore in the neighbourhood of the mouths of the largest glacier-rivers, where there is only a slight current and the water has become warm on the way, fertile tracts of meadows are often found where the glacier-water is profitably utilized for irrigation. Water from rivers such as Thjórsá and Hvítá has, by analysis, been proved to contain an unusually large quantity of alkali and phosphoric acid.

Lakes. There are many lakes in Iceland, but the majority of them are of small size. The largest lakes — Thingvallavatn and

Thorisvatn — cover an area of only about 100 square km. each: the lake-surfaces occupy therefore only a very small part of the entire area of the country. The lakes are of very diverse origin, the basins having been formed by tectonic movements, ice-erosion, volcanic action and other natural agents. On the plateau where the outlet is slight, especially in the neighbourhood of the large Jökulls (ice-mountains) many lakes occur, in some places gathered in large groups, as Fiskivötn on Arnarvatnsheiði NW. of Langjökull, and Veiðivötn W. of Vatnajökull; the melting snow and ice from the glacier-edges disappear in the nearest lava-streams and sandy tracts and then reappear and gather into basins many kilometres away from the glaciers from which they originated. In other places the lakes occur in the immediate neighbourhood of the glacier-edge, as Hvítárvatn and Hagavatn near Langjökull and Langisjór near Vatnajökull; the glaciers project into these lakes and calve their ice-bergs there; the water in these lakes is milky-white as in the glacier rivers. In some places lakes occur in between the glaciers (Grænalón near Skeiðarárjökull) or are dammed up in valleys by glacier-tongues. The best-known lake in Iceland is Thingvallavatn (105 square km.); it is situated in a new volcanic district bounded on the S. and W. by steep tuff-mountains and on the N. and E. by lava-streams which originate from the volcano of Skjaldbreið; these streams have afterwards flowed down between the two well-known fissures — Almannagjá and Hrafnagjá. It was here that the Icelandic Althing met in the time of the Republic. It appears as if the basin of the lake of Thingvalla was originally formed by subsidence along lines of fracture from SW. to NE.; this lake has a depth of 110 metres. In North Iceland Mývatn is the best-known lake; it is formed in a depression in the lava-stream and has a depth of only 2—7 metres; its bottom is lava and several craters project above its surface like islands, while the surroundings are very volcanic. Mývatn has received its name from the mosquitoes (mý) which are often quite a plague there. As in Thingvallavatn, trout are plentiful in this lake, but it is especially known as the abode of numerous birds, especially many different species of ducks. The group of lakes called Veiðivötn consists for the most part of crater-lakes, of which the largest is called Stórisjór. In other places valley-lakes occur — deeply hollowed basins in the basalt — as Skorradalavatn in Borgarfjörður and Lagarfljót in East Iceland, the surface of which latter lies 26 metres above sea-level while its bottom

lies 84 metres below the level of the sea. Lagoon-lakes, situated close to the coast, occur also, especially in North Iceland; the largest of them are Hóp, Höfðavatn and Miklavatn. According to the condition of the bars and the outlets the quality of the water of the lakes may often change quickly; sometimes they contain fresh water, sometimes brackish water, sometimes salt water. The fauna in these lakes is also subject to periodical changes. Sometimes marine animals immigrate through the outlets; at other times they disappear, and a freshwater fauna becomes dominant.

Fishing in the Iceland lakes is of great economic importance to the inhabitants. In the larger rivers and in many smaller streams, salmon is caught, and now the fishing is often rented out to English sportsmen, especially in south-west Iceland. Many rivers, and most of the lakes, abound in trout and salmon-trout (*Salmo alpinus* and *S. trutta*) which play a great rôle as a means of support of the inhabitants. The quantity of living organisms varies greatly according to circumstances; there appears to be most life in the shallow lakes, especially in those with lava-bottoms, in which warm or luke-warm springs are also sometimes found at the lake-bottom, around which plant- and animal-life collect. Some Phytoplankton (Diatoms) occurs in the lakes in South Iceland, but on the plateau and in North Iceland only Zooplankton (Daphnias) is found, and this is abundant. In Thingvallavatn, *Chara* and *Nitella* grow at a depth of 15—30 metres; in Mývatn there is a quantity of *Nostoc* which is found thrown up in great masses along the shores. In the lakes, there occur in addition, several species of *Limnæa* and *Pisidium*, and *Lepidurus* is frequently found in great quantities; there is, also, an abundance of gnat-larvæ and other larvæ which serve as food for the trout.

Geology. Iceland is almost entirely built up of volcanic rocks, none of which appears however to be older than Tertiary times. The foundation of the island is a depressed and broken basalt-plateau similar to the other Tertiary basalt-plateaus on both sides of the Atlantic Ocean, in East Greenland, the Færøes, Antrim in Ireland and on the islands of Mull and Skye. It is therefore assumed that in Tertiary times a continuous basalt-land extended across the Atlantic Ocean, that it subsided in Mid-Tertiary times and that Iceland and the Færøes are the remains of this land. In Greenland and on Skye the basalt rests on Jurassic strata, in Mull

and Antrim upon chalk; in Iceland, where the basalt formation has a thickness of at least 3000 metres, the underlying rock has not yet been found.

The principal rocks of which Iceland is composed are two, basalt and palagonite breccia; more than one-half of the surface and the rock-foundation of the country consists of basalt, but the palagonite formation, which is composed of breccias, tuffs and conglomerates of different age and which, taken as a whole, is younger than the basalt formation, forms an irregular band across the country, occupying an area somewhat smaller than that occupied by the basalt. Compared with these two formations, all other rocks and formations have quite an unimportant distribution. The basalt mountains, the precipitous walls of which often rise from the sea to a height of 600–1000 metres, are composed of layers of varying thickness, wedged in between each other; the thickness of the individual layers often decreases rapidly along a short distance until the layer disappears and gives place to another. In the basalt formation, beds of tuff and breccia sometimes occur between the basalt layers, but their amount is inconsiderable compared with that of the basalt. Dykes are frequent; the majority of them pierce down through the entire series of layers. Seen from a distance, the basalt-mountains with their steep, terraced walls, have a monotonous and gloomy appearance, but on closer inspection exhibit rather great variation. Some of the basalt layers are compact, others are coarsely crystalline, doleritic, porphyritic, amygdaloidal (with more or less completely filled vesicular cavities), slaggy, banded, etc. In some districts the basalt is cleft into beautiful columns; in others into more or less irregular, angular blocks; in others it has an almost slaty appearance. In the vesicular cavities of the basalt zeolites, quartz, chalcedony and calc-spar are often found. As a general rule the basalt layers have a slight inclination (3° – 5°) from the coast inwards towards the tuff and breccia formations, which appear to fill a flat, saucer-like depression in the underlying basalt plateau; but many local deviations occur owing to dislocations and subsidences of larger or smaller areas of the underlying rock.

In the middle of the basalt-formation in Iceland (as also in the Færøes and in Ireland) rather considerable clay deposits are found with the impressions and remains of plants of Tertiary times; also lignite and compressed tree-trunks, all called in Icelandic “*sur-tarbrandur*.” This plant-bearing formation attains its greatest thick-

ness (20—50 metres) in the north-western peninsula and was originally deposited at one level, but was afterwards broken up by dislocations, so that it now occurs at different levels above the sea. The surtarbrand formation consists of diversely coloured layers of clay and tuff with intercalated layers of lignite and coal-slate; in many places leaves and fruits are excellently preserved in it, especially near Brjánslækur on the northern side of Breiðfjörður, and at Tröllatunga and other localities near Steingrímsfjörður; in this

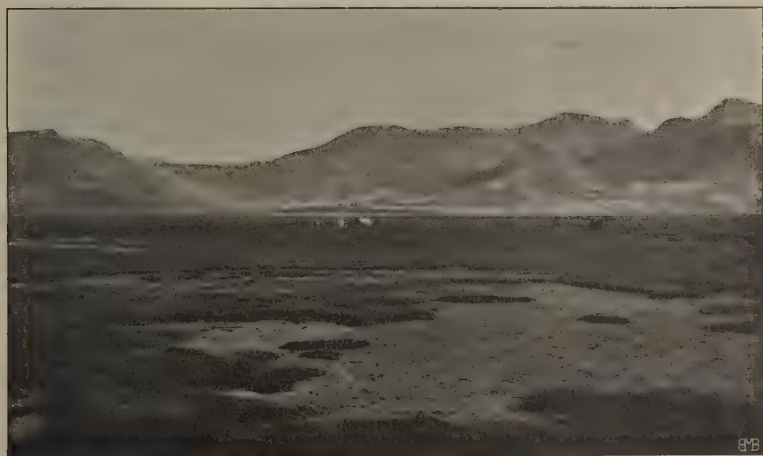


Fig. 4. Mountains near Kolviðarhöll (tuff and breccia).

last place it can be seen that large Tertiary woods have been destroyed by pumice-eruptions and lava-streams. According to O. Heer the mean temperature of the year in north-west Iceland, at the time of these Tertiary woods, was at least 9°C — probably somewhat more (11° — 12°); now the average temperature for the year in these places is only 2° . The most common tree in western Iceland at that time was *Acer otopterix*; its leaves are found in abundance and excellently preserved in the clay-layers; there occurred in addition *Sequoia Sternbergi*, *Pinus Steenstrupiana*, *P. microsperma*, *P. aemula*, *P. brachyptera*, *Betula prisca*, *Alnus Kefersteinii*, *Ulmus diptera*, *Quercus Olafssonii*, *Liriodendron Procaccini*, *Vitis islandica*, *Rhus Brunneri*, *Dombeyopsis islandica*, etc.

The Palagonite formation is composed of different kinds of tuffs and breccias, and in its upper divisions there is much moraine material and scattered glacial gravel, as also some ice-striated lava-

streams. The tuffs have usually a brownish-yellow colour owing to the intermixture of palagonite, a brown dully-lustrous alteration-product of tachylyte or basalt-glass, which constitutes the greater portion of the ground-mass of the rock; therefore the whole formation is often called the palagonite formation. The tuffs consist of lava-dust and lava-fragments with an abundance of glass-pieces (palagonite, tachylyte), slag and bombs; loose anorthite-crystals are often abundant. The breccias are distinguished from the tuffs by being



Fig. 5. Cliffs on Klifið (tuff and breccia). The Vestmannaeyjar.

more coarse-grained and containing larger, angular lava-pieces; the fragments consist of compact basalt, dolerite, pumice, slaggy lava and volcanic bombs; the separate fragments are often covered with a glassy crust. The palagonite formation is sometimes arranged in layers; sometimes not a trace of regular arrangement can be discerned. The tuffs and breccias have been formed by volcanic eruptions which chiefly ejected ashes and lava-fragments, and produced only a few lava-streams; the ruins of the numerous large volcanoes from which these eruptions proceeded may still be demonstrated. The palagonite formation is traversed by thousands of basalt dykes which branch and send out apophyses and intrusive sheets; very often the breccia and the tuff is filled with numerous hollow nodules and balls of basalt with a radially-columnar structure inside and

covered on the exterior with a crust of tachylyte. The tuff-formation appears to consist of several divisions the mutual relation of which has not, however, yet been elucidated.

All round Iceland, in both the basalt and the tuff formations, small patches of *liparite* occur. This rock occurs in small intrusive beds and dykes which, on account of their light colour, are distinguishable from the dark basalt and can therefore often be seen from a distance. The liparites vary very greatly both in colour and in structure, and in places where larger sections are exposed, the colouring is often richly variegated. Liparites are almost always accompanied by many closely allied, glassy rocks, especially pitchstones, which occur as dykes, perlites, sphærolites, obsidian and pumice. In south-east Iceland and on Snæfellsnes, veins of *granophyre* are found in some places. The rocky promontories on each side of the Bay of Lón in south-east Iceland consist of *gabbro*, probably of Tertiary age; this rock is also found under the névés of Vatnajökull, because many of the glacier-rivers carry down an abundance of pebbles of gabbro. The liparites and allied rocks, which on the whole cover an area of about 800 square km., are distributed all over the island, but most frequently in larger quantities in East Iceland. Liparite eruptions have taken place at all periods from the earlier Tertiary times to the present day; some volcanoes which have been active within historic times have ejected liparitic pumice. In the neighbourhood of Húsavík in North Iceland are found, near Hallbjarnarstadir, marine deposits with abundant shells of mussels and snails dating from the end of the Tertiary epoch, from the period called in England the *Red Crag*; these formations are found nowhere else in Iceland.

In central Iceland, where tuff and breccia form the foundation, large areas are covered by old *ice-striated lava-streams*. These lava-streams are distinguished from the lavas of the present day by their colour and structure. The modern lavas are usually dark in colour with a compact basaltic structure, while these ice-striated lavas have lighter colours and a doleritic structure. These dolerite-lavas, during the Glacial period and immediately after, flowed from dome-shaped lava-cones with large crater-openings, here and there still extant; or sometimes from large "Bedded Volcanoes" (Strato-Vulkane) the ruins of which — half destroyed by erosion — are still to be found here and there within the area of the palagonite formation. These ice-striated lavas are of different ages; some of them

have been produced before the surface assumed its present form, others have been formed after the country had in all essentials acquired the sculpture it has to-day; several of them have flowed down through valleys and hollows. Reykjavík is built upon such a doleritic lava-stream, and there the dolerite is much used for building purposes. In several places the glacial lavas are of considerable thickness (100—200 metres and more). Some larger volcanoes, which have been in eruption as late as within historic times (Eyjafjallajökull, Snæfellsjökull, Örfajökull), began their activity even during the Glacial period and at that time discharged doleritic lava-streams. In several places in West and South Iceland large deposits of conglomerates occur, with rolled gravel and sand, alternating now and then with moraine material and ice-striated lavas; these resemble the "Nagelfluh" of the Alps and were perhaps formed in a similar manner.

During the Glacial period the whole island was wrapped in a sheet of inland-ice through which only a few small peaks projected here and there near the edges. The Jökulls (snow-fields) of the mainland probably extended on all sides down to the sea, for the bottom-moraines of that time are found everywhere, both on the plateau and in the lowlands; the lateral and terminal moraines which occur in the valleys and lowlands, date from a later period when the ice was retiring; it appears also that large masses of moraine-material occur here and there on the sea-bottom off the mouths of the fjords. The north-western peninsula was probably covered with a separate ice-sheet, from which numerous small glaciers, with intervening ridges free from ice, descended to the sea. The ice-sheet of the Glacial period had, on the interior plateau, a thickness of 700—800 metres. Ice-striated rocks occur all over the island, both in the high land, in the valleys, and in the lowlands, as also on islands and skerries. Large and small erratic blocks are found in thousands scattered over the whole of Iceland.

As mentioned above, it is assumed that Iceland, in the beginning of Tertiary times, was connected by a broad land-bridge with Greenland, the Færøes and Scotland; this land-bridge was a volcanic highland or plateau-land formed by innumerable lava-streams which originated principally from rows of craters and from fissures. The plateau, which had a height of 3000—4000 metres above sea-level, was towards the end of the Miocene period broken up and depressed; by this subsidence, perhaps in conjunction with

abrasion, the countries were separated and have never since been connected with each other. But Iceland was then, after the separation, considerably larger than it is now, the land extending 50—100 km.

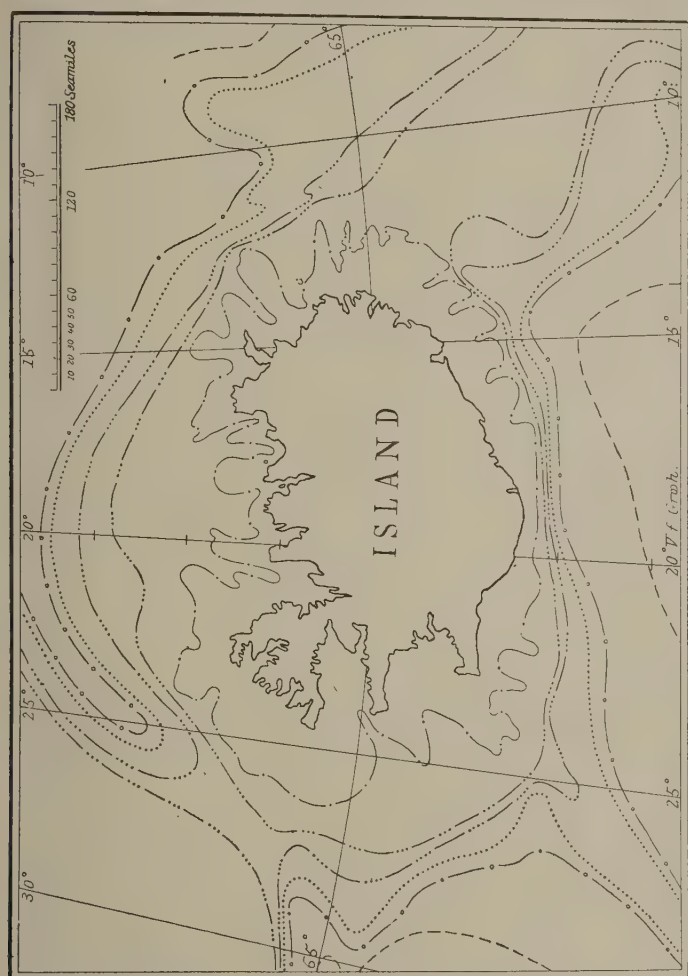


Fig. 6. Depth of the sea around Iceland.

The lines from the coast outwards indicate depths of 100, 300, 600, 700 and 1000 fathoms respectively.

further out on all sides. The subsidence continued gradually, but perhaps with less intensity than before, through Pliocene times, and the submarine coastal platform, which occurs around the whole island and is limited by the 100 fathom line, was simultaneously formed by denudation: the abrasive action ended in the Red-Crag time.

In the Pliocene period Iceland was fissured transversely by numerous lines of fracture which caused violent volcanic action, by which the tuffs and breccias of the palagonite formation were produced. Along the same lines the volcanoes of the Glacial period and of the present day appeared. From the end of the Pliocene period to the present time the coast-line has been subject to considerable changes the boundary-values of which appear to be a positive displacement of 150 metres and a negative displacement of 250 metres of the position of the sea-surface relative to the land. At the end of the Pliocene, or during the earliest part of the Glacial period, the coast-line sank about 250 metres below the present level, and in the broad coastal platform which thus became dry land, erosion-grooves were formed leading off from each main valley. Now, each fjord and bay is continued out to the edge of this submarine platform by submarine fjords, as has been proved by the soundings taken of late years by the Danish Marine Department.

The marks left by a negative displacement of the coast-line in post-Glacial times occur around the whole coast, but are especially well-developed round the north-western peninsula. Everywhere along the rocky coast are found marine terraces of gravel, coast-lines and surf-terraces marked on the solid rock; in several places remains of shells are also found and sometimes bones of whale and walrus, also old drift-wood; sometimes far from the present line of coast. Round the north-western peninsula occur distinct and well-developed coast-lines and surf-terraces at two levels (70—80 metres and 30—40 metres above sea-level); such are also found on other parts of the coast, especially the lower line; the upper line is rarely as distinct as the lower one; in some places on the main land there appear to be indistinct marks of a water-level up to 100—150 metres. In South Iceland caves, hollowed out by the surf during the time of a higher water-level, are rather common, and marine clay-formations occur upon all the low land, the latter having been submerged during the final part of the Glacial period. In the clay-deposits in south-western Iceland, *Yoldia arctica* and other High Arctic molluscs are found at a level which corresponds with the higher coast-line (70—80 metres); other shell-mounds, with a fauna which resembles the present one, correspond with the level of the lower coast-line (30—40 metres), *Saxicava* is especially characteristic of these shell-mounds. Since the Glacial period the coast-line has retreated, but with some oscillations, and even now several indications may be

observed affording evidence of an upheaval of the land in our own day. Shortly after the Glacial period the climate was somewhat milder than it is now; in northern Iceland abundance of *Purpura lapillus* has been found in shell-mounds, and this still lives in the sea south of Iceland, but not in the colder water along the north coast. In bogs on the northernmost headlands, where birch woods no longer thrive, remains of *Betula alba* are found, while *Betula verrucosa*, which no longer grows in Iceland, has been found in the bogs of South Iceland.

Volcanoes and Lava-streams. Iceland is one of the most volcanic countries in the world; as mentioned above, the island throughout has been built up by volcanic activity which began early in Tertiary times and has continued to the present day. There are records to hand of 138 eruptions from 30 volcanoes within historic times, but many eruptions undoubtedly took place in early times which either were not recorded or occurred in the inland wastes and snow-fields without being noticed by the inhabitants. At the present time, 130 post-Glacial volcanoes are known in Iceland, and several volcanic vents have undoubtedly still to be found, or else have been effaced or destroyed by erosion. All the numerous volcanoes have, in the course of time, since the Glacial period, discharged enormous quantities of lava, and the post-Glacial lava-fields of Iceland cover an area of about 11 200 square km.; they occur over the country in vast expanses around the volcanoes from which they have originated. The majority of these lava-fields have been produced not by one but by numerous eruptions at various times, and the greater part of the lava dates from pre-historic outbursts. The largest lava-stream which has been poured forth during a single eruption within historic times, is that which issued from the craters of Laki — a row of craters formed in 1783; this stream covers an area of 565 square km.; and its mass occupies about $12\frac{1}{3}$ cubic kilometres; it is probably the largest lava-stream upon the surface of the earth which, within historic times, has been known to flow out during a single eruption. The largest continuous lava-field in Iceland is Odáðahraun on the plateau north of Vatnajökull (600—1200 metres above sea-level); it was produced by numerous eruptions from more than 20 volcanoes, and covers an area of about 4000 square km. The lava-field, next in size, which originated from the many large craters near Veiðivötn, west of Vatna-

jökull, and extends down to the south coast near Eyrarbakki, covers an area of 1550 square km. In the low land this lava-field is covered by a thick layer of soil upon which dense settlements have arisen. In addition, extensive lava-fields (1530 square km.), which originated from 28 volcanoes, occur on Reykjanes; and upon the plateau on either side of Langjökull, there are also other large lava-fields (1030 square km.) of which Hallmundarhraun is the best known; in it is the lava-cavern, Surtshellir, which is $1\frac{1}{2}$ km. in

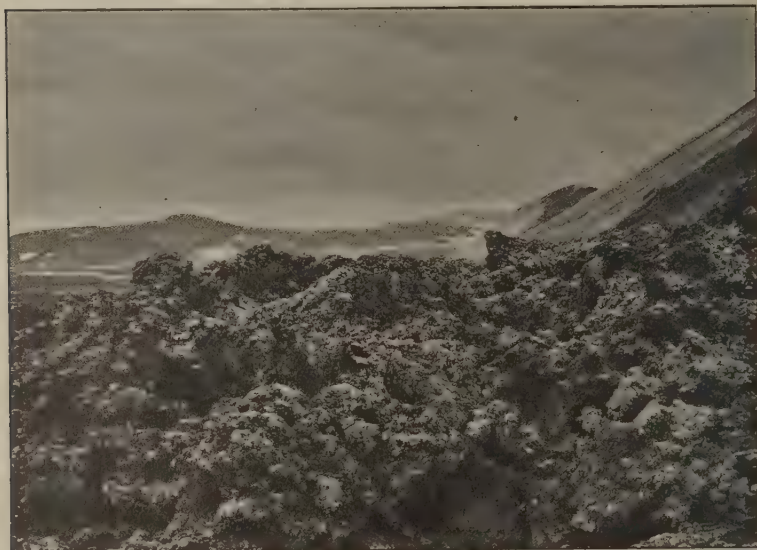


Fig. 7. Lava-stream (apalhraun); upon the outer south-west slope of Dyngjufjöll.
(Phot. Heinrich Erkes.)

length. Large tracts of lava occur also around Hekla, near Mývatn, Kelduhverfi and in several other places.

The surface of the lava-streams varies greatly; often it is very rugged and jagged and is then, in Iceland, called *apalhraun*, and in the Sandwich Islands, *aa*. Such streams consist exclusively of porous and brittle lava and slaggy fragments heaped together pell-mell. Such lava-streams are comparatively narrow, with high edges which, seen from a distance, look like fences or ridges upon the level land. A lava-stream of this description is very difficult to cross, owing to the fragments being put together so loosely that they are disturbed by the slightest touch. Other lava-fields, especially the

large ones, have another variety of surface — lava-sheets — which may sometimes be level, but are more frequently broken and cracked in numerous directions; in Iceland they are known as *helluhraun*, in the Sandwich Islands as *Pahoehoe*. Upon the smooth surface, numerous tangled and twisted lava-ropes may be seen, bent in long curves following the undulating surface of the viscous lava. Sometimes this lava is compact, and without great irregularities of surface, but more frequently, by cooling, the surface has subsided and



Fig. 8. Sheet-lava near Frambruni. Slope of Trölladyngja on Odáðahraun.

(Phot. Heinrich Erkes.)

broken into large pieces, forming a number of hills, ridges, embankments and cauldron-shaped depressions, giving to it the aspect of a rough sea with high waves. Sometimes the surface of this sheet-lava is arranged in knots, curls and folds, all as smooth as hardened pitch. Beneath the lava-sheets there are often empty spaces, like drain-pipes and tunnels, and sometimes large caverns. Both forms of lava are sometimes found combined in the same stream. Long clefts often occur in the lava-streams, and sometimes enormous cracks, which are due to the subsidence of the substratum. Of lava-clefts of this description Almannagjá near Thingvellir is the most famous. In Odáðahraun there are also lava-clefts, 10—15 km. in

length. Groups of small slag-cones (craters) and lava-kettles (*Hornitos*) are very common in the lava-fields; they are often gathered together in hundreds upon a relatively small area and without any regularity



Fig. 9. Lava streams in vertical section (Almannagjá).

of arrangement. These slag-cones are secondary formations, usually associated with lavas which have overflowed marshy ground and lakes, and have thereby absorbed quantities of water-vapour; they are of frequent occurrence near Mývatn, on Reykjanes, and especially at Landbrot.

Large areas of Iceland are, moreover, covered with volcanic ashes, slags and bombs ejected by volcanoes. During the eruptions, the fine ashes are often spread out over a large part of the country and are sometimes carried by the wind across the Atlantic Ocean. During the Katla eruption in 1625, the ashes were carried to Bergen in Norway, and in 1845, ashes from Hekla were carried as far as to Germany, and during the Askja eruption in 1875 the volcanic dust was carried to the west coast of Norway in eleven hours forty minutes, and in another ten hours they travelled as far as Stockholm. Ashes and slag are thrown up into the air to a great height; on April 21, 1766, the ash-column of Hekla had a height of 5000 metres above the summit of the mountain, and it has often been higher still. Lava fragments and bombs are shot into the air to a great height and often fall at a distance from the place of eruption; during the Hekla eruption in 1510, a man was killed by a volcanic bomb at Skálholt, 45 km. from the volcano; during the eruption of the same mountain in April 5, 1766, a volcanic slag, as big as a man's fist, was hurled to Viðivellir in Skagafjörður, 165 km. from the mountain. The fine dust which fills the air during great eruptions, causes peculiar refraction-effects in the air; thus, during the Laki eruption of 1783, dust-clouds and unusually brilliant sunsets were common over the whole of Europe, North Africa and a part of western Asia. The ashes fell in such quantities in Caithness in Scotland as to destroy the crops; that year is still spoken of by the inhabitants as "the year of the ashie." The shower of ashes, together with the red-hot scoriæ ejected in an eruption, often causes considerable damage to the inhabited land. Pastures are buried beneath them or are scorched, and the coppice-woods often suffer severely. Whether the damage done by the ashes to pastures is permanent or not greatly depends upon their nature; the heavy basaltic ashes are especially injurious, as they can only with difficulty be carried away by the rain or by irrigation. When, however, the layer of ashes is thin it gradually is absorbed into the soil, by the grass growing up above it. In the neighbourhood of larger volcanoes, several layers of ashes, one above the other, are found in the soil. The light, liparitic pumice-ash, which is rarer, is less injurious, as it is quickly carried away by water. Sometimes the ashes discharged by a volcano contain a great quantity of acids; during the Laki eruption of 1783, the ashes were so acid that they burnt holes in the burdock leaves, and left black patches on the

sheep's skins, and the hoofs of the sheep turned yellow when they walked amongst them; while the rain which fell from the dust-clouds, is said to have been so sharp and biting that it was painful where it fell on the hands and face. The volcanic eruptions, on the whole, have had a very injurious influence upon the plant-distribution in the volcanic regions of Iceland. During the eruptions a great number of sheep and cattle die from want of food or from its unwholesome nature, and of various diseases caused by the ashes eaten with the fodder. No eruption has however been so disastrous as the eruption of the Laki crater-rows in 1783. In the winter which followed, and in the spring of 1784, the sheep and cattle suffered from all kinds of diseases owing to the unwholesome food, and died by scores. On many farmsteads the entire live-stock died out, and the following year there died in the whole of Iceland 11,500 cattle, 28,000 ponies and 190,500 sheep — about 53 per cent of all the cattle, 77 per cent of the ponies and 82 per cent of the sheep. Then came a famine, which carried off 9500 of the inhabitants, about one-fifth of the total population of Iceland at that time.

In Iceland there are several types of volcanoes. Usually, by a volcano is understood a large hill or mountain, more or less conical in form, which is ignivomous, discharging lava-streams and ejecting ashes and fragments of lava. Volcanoes of this description occur in Iceland, but are not common; seven or eight such volcanic mountains are known, which resemble externally the well-known Italian volcanoes of Vesuvius and Etna, without however being so regular in form; they are built up of alternating layers of ashes, lava and slag, and usually resemble truncated cones with a crater at the top, and a considerable angle of inclination (at the base 8° — 15° ; at the top 20° — 35°); the majority of them have their summits covered with snow and glaciers. Of these volcanoes the largest and best known are Öraefajökull, Snæfellsjökull and Eyjafjallajökull. Hekla is also built up of alternating layers of lava and tuff, but is not conical. Its shape conforms to an elliptical ridge, rent down its major axis, and studded with a row of craters along the line of fissure. Another type of Icelandic volcano are the dome-shaped "lava-cones" (*dyngja*, pl. *dyngjur*) — larger or smaller volcanoes, built up entirely of lava-streams, without any intermediate layers of tuff or slag. Volcanoes of this description, which are also found in the Sandwich Islands, are distinguishable from the country surrounding them as shield-shaped cones, and their altitude is low

compared with their extent. The largest have an altitude of 1400—1600 metres, and a diameter of 10—15 km. On such dome-shaped lava-cones the angle of inclination at the top of the mountain is only slightly greater than near the base, seldom exceeding 7° — 8° , and more frequently still less, often only 1° — 2° . The summit of such volcanoes consists of a circular or elliptical mouth or depression, often of large dimensions, some having a diameter of 1000 metres or more. The walls of the depression (crater) are usually



Fig. 10. Row of craters.

cleft by concentric fissures, so that the descent from the lip to the bottom of the crater is, as it were, a series of steps. The sides of these volcanoes are entirely covered with knotty sheets of lava, and long tunnels and caves are very common in the sides of the volcano. In some cases the depression is filled with lava to such an extent, that the only indication of the circumference is a ring of small lava-pinnacles and lava-ridges. The immense lava-waste of Odáðahraun was mainly formed by outpourings from this type of volcano, of which Trölladyngja (1491 metres) is the largest. Another well-known volcano of this description is Skjaldbreið near Thingvellir. Of post-Glacial lava-cones, 16 are known from Iceland. These lava-cones were also very common during the Ice Age.

The greatest amount of lava which has been poured forth in

Iceland, issued from volcanic fissures and crater-rows; these are not volcanic mountains, but rows of low craters established along the direct line of a fissure, more frequently upon level land. Of this kind of eruptive vent, 87 are known from Iceland at present. Each of the craters in such a chain occurs independently and is built up of scoriæ and lava. They are usually low, rarely exceeding a height of 100—150 metres, while the majority of them are even considerably lower; they are often very irregularly formed and composed of several rings. Some crater-rows are very long; they often attain a length of 5—10 km., and some are longer still, as for instance, the Laki crater-row of 1783, which has a length of 30 km., and contains about a hundred separate craters of various sizes. Some crater-rows are so small that they resemble toy-volcanoes. In some places the lava has welled up out of fissures in large streams without any visible craters. The largest of these fissures is Eldgjá, north of Mýrdalsjökull; it has a length of 30 km., and has poured out lava-streams sufficient to cover an area of about 700 square km. In some places “explosive craters” occur, cauldron-shaped depressions produced by a single volcanic explosion. The best known of these craters is Viti, on the side of Mount Krafla, north of Mývatn. It was formed by a sudden outburst on May 17, 1724. For a long time afterwards there was a large, boiling slough at the bottom of the crater, but this is now converted into a greenish-coloured quiescent lake. The majority of the volcanoes in Iceland are basalt volcanoes, and have poured out streams of basaltic lava, and ejected basaltic slag and ashes. Only in the neighbourhood of Torfajökull liparitic volcanoes occur — of post-Glacial origin, and of peculiar aspect — which have poured out lavas rich in silica. The interior of the lava-mass is grey or reddish brown, but the surface of it is jet-black, as it consists of obsidian, covered here and there by light, almost white, pumice. The largest liparitic lava-streams are those called Hrafninnuhraun and Dómadalshraun. In some places streams of liparitic blocks in a half-melted condition have flowed out from craters in the mountain-sides, and several volcanoes have ejected liparitic pumice, as for instance, the volcano of Askja, 1875. Many volcanoes in Iceland are buried beneath the snow and the glaciers, and as mentioned above, when they break out into eruption, large masses of ice are melted and the glaciers burst, which causes the neighbouring level lands to be inundated by enormous floods of water, with huge fragments of ice tossing on

its surface. The Katla eruption, in this way, converted thickly inhabited and fertile tracts into deserts, and in 1362 Öræfajökull destroyed, in the same way, two parishes, sweeping away forty farmsteads with their inhabitants and live-stock and all else, out into the sea.

The best-known Icelandic volcano is Hekla. It has been the scene of 21 eruptions during historic times; next in importance comes the glacier-volcano Katla of which 13 eruptions are recorded.

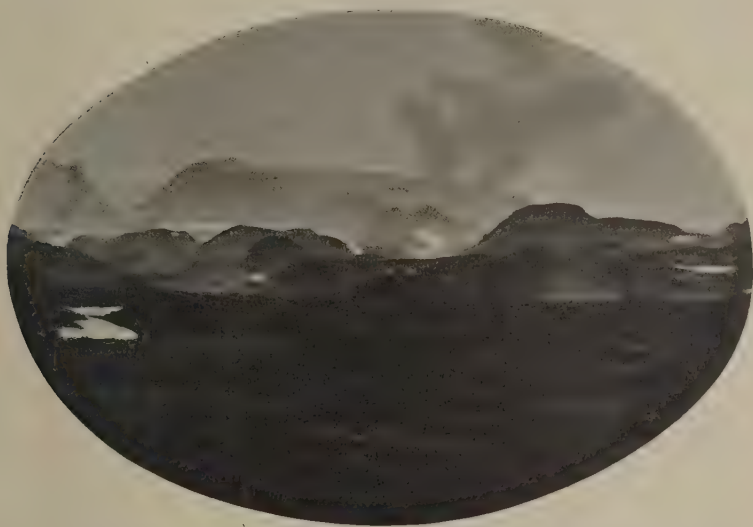


Fig. 11. Kverkfjöll, a volcano on the northern edge of Vatnajökull; seen from Hvannalindir.
(Phot. J. P. Koch.)

Submarine eruptions have taken place some ten to twelve times near Eldeyjar off Reykjanes, whereby new islands have had their origin; but these have disappeared again. Several volcanoes are present beneath the ice-cap of Vatnajökull, but the foci of eruption are not known for certain. During the last two centuries, from 30 to 40 eruptions have been recorded from the snow-fields of Vatnajökull. During several of these eruptions the snow and ice on Skeiðarárjökull, on the southern side, partially melted, and enormous torrents of water were discharged. Occasionally Brúarjökull, on the northern side, has been very active. On Reykjanes there are numerous pre-historic volcanoes and rows of craters, and in three or four places eruptions have taken place since there have been settlements on

the island; one of the most active volcanoes on Reykjanes is called Trölladyngja. The best-known volcano near Mývatn is Leirhnúkur, but besides this, many smaller crater-rows and separate craters occur; the volcanoes near Mývatn were particularly active during the years 1724—30. In the centre of Odáðahraun rises the volcanic mountain-group Dyngjufjöll with the crater-valley of Askja; it is one of the largest volcanoes of Iceland. The crater-valley, which is surrounded by circular mountain-walls, covers an area of about 55 square km. In the south-eastern corner of it there is a deep volcanic depression with a lake; at the edge of the latter a new crater opened on March 29, 1875, and discharged an enormous quantity of pumice over the eastern part of Iceland and, as mentioned above, the dust was carried as far as to Scandinavia. The greatest eruption which has taken place during historic times in Iceland was the eruption of the above-mentioned crater-rows of Laki in 1783. The lava which poured forth filled valleys, altered the course of rivers and destroyed several farmsteads, fertile meadows and extensive pastures. North of Iceland submarine volcanic eruptions have occasionally taken place.

Almost all the volcanoes of Iceland are associated with fissures in the tuff and breccia areas of the palagonite formation. In the southern part of Iceland all the mountain-ridges, valleys and rivers exhibit a decided dependence on tectonic lines of deeply situated fracture from SW. to NE. Open fissures in the surface, all the numerous crater-rows, and the lines joining the volcanoes, have a similar direction. Moreover, hot springs — both alkaline springs and sulphur springs — are arranged along the same lines. In North Iceland, on the other hand, the tectonic lines and the fissures and volcanoes, have generally a direction from S. to N. Both these directions probably are combined in a curving band of fracture-lines which lies across the island. In the basalt plateaus of the west coast there are several cauldron-like fissures and concentric fractures, and along the southernmost of these depressions, which extend over both the tuff and breccia areas around Faxaflói, the volcanoes and hot springs are arranged in a semicircle.

Earthquakes are very frequent in Iceland not only in connection with volcanic eruptions, but also apart from them; in the latter case they are chiefly confined to three districts with well-marked natural boundaries. All the greater earthquake shocks are tectonic

in origin; that is to say, they are due to movements and subsidences of large tracts of land bounded by dislocations and fractures of the ground. In North Iceland, between Skjálfandi and Axarfjörður, where the new volcanic tuff district extends to the coast, violent earthquakes are frequent, especially in the neighbourhood of the trading-station of Húsavík. The earthquakes of 1755, 1872 and 1885 were especially serious and did great damage in these districts. At Faxaflói there is another earthquake-area where minor shocks are very common; they are usually most violent on Reykjanes, especially in the neighbourhood of Krisuvík, and at the extreme point of the peninsula, near the lighthouse. The third earthquake-area comprises the southern lowland area between Reykjanes and Eyjafjallajökull. This district has frequently suffered from violent and destructive earthquakes which have caused great loss of human life and of property. In modern times the earthquakes of 1784 and 1896 have been especially destructive. The former (Aug. 14—16) completely ruined 92 farmsteads, and damaged 372 houses and 11 churches. In August and September, 1896, the earthquake shocks were even more violent. Great chasms were rent in the earth, some as long as 15 km.; water-courses were altered and the position of hot springs changed; quantities of hugh fragments of rock were loosened from the mountain-sides; 161 farmsteads were hurled down, and 155 more were greatly damaged; in fact, every house in this area sustained some damage. By each of these violent earthquake shocks a limited tract of land was put in movement. Occasionally, North Iceland has been shaken by volcanic eruptions which originated under the sea off the north coast of the island; this was the case in the years 1838, 1899 and 1910.

Hot alkaline springs occur in hundreds in Iceland, scattered all over the country, sometimes singly, sometimes in groups. At the present time 677 hot and boiling springs are known in 162 localities, and the majority of them are closely dependent upon the fracture-systems of the island. Earthquakes exert great influence upon these springs; many disappear or are altered, and new ones are formed. The surfaces of the springs have any temperature up to boiling point. Tepid springs which can be used for bathing are called "laugar," boiling springs "hverar." Some of the latter throw up jets of water as Geysir does; but otherwise the boiling springs may be divided into five classes: (1) springs which are constantly

spouting, (2) intermittently spouting springs, (3) alternately spouting springs, (4) constantly boiling springs which do not spout, (5) springs with a high temperature and a quiet surface or which boil quietly in the middle. All the boiling springs deposit siliceous sinter. The most famous hot spring is Geysir, in the vicinity of Haukadalur in South Iceland, in the centre of a group of other boiling springs. This group of springs was mentioned for the first time in 1294 and has often undergone alteration by earthquakes, especially in 1630 and 1789. Geysir's eruptions now take place very irregularly and many days may intervene between them. At the end of the 18th and the beginning of the 19th century, Geysir's activity was at its maximum, and it could throw up fountains of water to a height of 50—60 metres, whereas now the water rarely rises above 30 metres. The neighbouring hot spring Strokkur, began its activity in 1789 and ceased during the earthquakes of 1896. At first Strokkur threw up higher fountains of water than did Geysir, not only boiling water and steam, but also cold water. Other large groups of hot springs are found near Reykir in Ölfus, in Reykholtsdalur, on Hveravellir on the plateau NE. of Langjökull, and in many other places.

Sulphur springs occur in abundance in the volcanic districts, but not outside the palagonite-formation; also alkaline springs are common in the basalt districts. The alkaline springs are found upon the level land, in valleys and upon mountain-sides where there is much underground water, but the sulphur springs commonly occur upon mountain ridges and other dry localities where the water has an outlet through the underlying lava, etc. Several of the solfataras deposit a considerable amount of sulphur in small heaps where the sulphurous vapours rise from the soil. Sulphur from Iceland had a commercial importance even in the 13th century, and the trade in sulphur was especially lucrative in the 16th century. Since that time the export of it has gradually decreased and now has entirely ceased. The sulphurous vapours which rise through the clefts and cracks in the earth have a great effect upon the neighbouring rocks, which are transformed and decomposed in various ways — coloured clays, gypsum, iron-alum (Halotrichit), etc. being formed. The mountains which have been penetrated by the hot sulphurous vapours are easily recognizable at a long distance, owing to their naked and discoloured appearance; they are always light-red, yellow and white in colour and are entirely destitute of plant-

growth. While plant-growth is abundant in the neighbourhood of the alkaline hot springs, from the vicinity of the sulphur springs it is almost absent. In places where surface-water or underground water is found, mud-holes are formed, or larger or smaller sloughs, in which clayey mud of various colours boils and bubbles; it is sometimes ejected a few feet upwards, whereby crater-like mounds are formed around the larger pits, bearing a weird resemblance to



Fig. 12. Solfataras of Krisuvík.

large cauldrons of boiling porridge. The majority of the sulphur springs occur on Reykjanes, in Hengill, near Krisuvík and at Cape Reykjanes where the large slough of Gunna is well-known. Moreover, extensive sulphur-spring districts (Námufjall, Krafla, Fremri-námur) occur near Mývatn, and Kerlingarfjöll near Arnarfellsjökull is another, upon the interior plateau. Carbonic acid springs (*ölkeldur*) and Mofettes occur here and there, especially on Snæfellsnes in western Iceland; the best-known carbonic acid spring is found near Raudimelur in Hnappadal. Ores, metals and stones of any great commercial value are not found in Iceland. Here and there some lignite occurs which is utilized by the neighbouring inhabitants. The gathering of sulphur is no longer lucrative, but,

as already mentioned, in East Iceland calcareous spar is quarried at Helgustaðir near Reydarfjörður and is used by the makers of optical instruments.¹

¹ For fuller notes on the Physical Geography and Geology of Iceland the reader is referred to the following papers by Th. Thoroddsen: *Island. Grundriss der Geographie und Geologie*: Justus Perthes, Gotha, 1906 (358 pages). *Lýsing Islands*, Köbenhavn, 1908—1911, in 2 vols (365 and 673 pages). *Explorations in Iceland during the years 1881—98* (*The Geographical Journal*, London, 1899, Vol. XIII, pp. 251—274, 480—513). *Vulcane im nordöstlichen Island* (*Mitteilungen d. k. k. Geogr. Gesellschaft*, Wien, 1891, pp. 117—145, 245—289). *Geological Map of Iceland. Surveyed in the years 1881—98*. Edited by the Carlsberg Fund. Copenhagen, 1901, Scale 1 : 600,000.

II. CONDITIONS PERTAINING TO SURFACE AND SOIL.

AFTER having thus given a brief, general survey of the orographical and geological conditions and having described the substratum and general structure of the island, we will now pass on to a description of the surface itself, with which plant-growth is more particularly associated. As mentioned above, Iceland is built up of basalt, tuffs and breccias, but basalt is the fundamental rock; the tuffs and breccias are, for the most part, nothing else but basalt split and pulverized. The mineralogical and chemical composition of the soil is therefore essentially the same over the entire island, provided the siliceous liparites are excepted which have no effect of any importance to the whole.

Seen from a distance, the basalt mountains usually appear to be steeper than they are in reality, and the small terraces or steps of the layers of basalt are not distinguishable in the higher part of the mountain from a distance except when they are snow-covered or when, as rarely happens, a scanty vegetation (especially mosses) has been able to gain foothold upon the narrow ledges. The rule is that the steps of the basalt mountains become broader as the base is approached. At the top the separate layers project as a narrow ledge which is only half, one, or two metres broad, but lowest down in the valleys, and nearest to the sea the separate layers form enormous terraces which may attain a breadth of $\frac{1}{4}$ — $\frac{1}{2}$ km. or more. The upper surface of these broad terraces is covered with gravel and clay, and sometimes with a scattered plant-growth, or sometimes with a continuous vegetation, with bogs or swamps; there, enormous, elongated snow-wreaths may persist far into the summer. On basalt mountains erosion is more active on the sunny side, therefore the other side is steeper and more sparsely covered with plants. On the sunny side the average inclination is usually

only 20° — 25° , but upon the other side 30° — 35° . There are, however, a few basalt mountains which are much steeper than this: for instance Skessuhorn near Borgarfjörður, which has an inclination of 48° . In the numerous erosion-channels on the mountain sides, where gravel and stones are constantly rattling down and avalanches are frequent, it is difficult for the plants to gain foothold. The ridges between the mountain streams are therefore more closely covered with plants but, as already mentioned, a continuous plant-



Fig. 13. Basalt mountains with snow-wreaths (Isafjörður).

covering rarely extends higher than half-way up on the basalt mountains. In olden times the mountain sides were in very many places clad with coppice woods, but these disappeared at an early date, partly owing to the havoc wrought by sheep and partly to man's lack of foresight. Now only some stunted shrubby birches are to be seen upon inaccessible cliffs, where they are beyond reach of man and beast, even with the utmost exertion. Upon mountain-sides deprived of their birch-copses, avalanches of snow and stones have suffered no hindrance, so that all soil and plant-growth have disappeared, thus turning the mountain-sides into naked, gravelly and rocky slopes. In some districts such changes have taken place

even as late as in the 19th century. Where the basalt mountains are not too steep nor the mountain-streams too torrential, the flat gravel-cones upon the valley sides, below the notches in the mountain, are often overgrown with plants. These gravel-cones often underlie the home-fields of the farmsteads.

In the fjord districts of Iceland the vegetation upon the basalt mountains differs considerably in passing from the sea inwards. Owing to the effect of the sea-water, the violent storms and the rawness of the climate, the outermost points are comparatively poor in plants, while the vegetation increases inwards towards the valley, and in the bottom of the valleys, especially on the north-western peninsula, remains of coppice woods are often found; but woods could not thrive out along the fjords, still less at the extreme points. Where the basalt does not occur as steep cliffs and is not covered by loose layers of clay, glacial gravel and soil it is usually strewn with loose sharp-edged fragments, split and torn off by frost. The severance of these fragments usually follows the cleavage of the basalt, and they are sometimes slaty and in thin plates, a condition which is especially common in the uppermost part of the basalt formation. Upon the split and torn basalt in the uppermost part of the mountains, plants have difficulty in gaining foothold, especially when the climate is as raw and stormy as is the case in Iceland. Therefore, large areas of the higher-lying basalt districts are extremely poor in plant-life even in places, where according to the situation, the conditions might be expected to be somewhat more favourable.

The landscape in the tuff and breccia districts has a different appearance. Basalt mountains usually have sharp, and breccia mountains soft outlines. Those areas of the cultivated districts and on the lower spurs of the highland which are built up of tuff and breccia have often a more or less undulating appearance; the mountains are broken down into numerous rounded ridges and protuberances with intervening stretches of level ground and valleys of irregular shape; but here and there are seen tabular mountains or promontories with steep sides and a flat surface, where the basalt or dolerite has covered and protected the tuff and the breccia. On the plateau, where through centuries storms have been continually altering the sculpture of the surface, the soft tuff-mountains have suffered in particular; here the tuff-ridges are connected into irregular chains which have been eroded in every possible way, and often resemble fantastic ruins with numerous sharp peaks, protuberances

and knolls separated by sandy areas and labyrinths of branched clefts and small valleys. Tuff mountains, owing to the loose nature of the rock, are relatively poor in water as the latter often disappears into the ground, and does not appear until at a distance from the mountain. This is especially the case with the tuff-mountains on the plateau where, during summer, not a single stream or spring is met with for long distances, but only large, deep, dry river-beds and water-courses filled with coarse gravel and large



Fig. 14. Remaining portion of a "móhella" upon a wind-eroded gravelly flat (örfoka).

boulders. These river-beds are due to the melting of the snow in spring or during periods of thaw in winter when, for a short time, they are all filled with torrential floods of water.

The surface of the breccia mountains is usually concealed by loose, angular and porous fragments of lava which have been disintegrated from the breccia; the nature of the rock is often seen only in clefts and in a few prominent protuberances and projecting rocks. The power of resistance of the rock against the action of water and wind differs however greatly, because tuff and breccia are of all possible degrees of hardness, although a loose texture is the most common. Tuff is easily disintegrated, and water and wind

carry the finer palagonite-dust down into the valleys or to distant quarters of the island where it is deposited and retained by the vegetation, frequently forming thick layers (móhella). The heavier lava-fragments which have thus been deprived of matrix are left behind. On stretches of level ground the lava-gravel, thus loosened, sometimes attains a thickness of several metres. As a general rule the surface of the tuff-mountains is much affected by the action of water and air and along the sides of the fissures the effects may be traced far down. Sometimes these fissures are filled with zeolites, calcite or gypsum; and sometimes the mass which fills the fissures is harder than the surrounding rock so that the surface presents the appearance of a network of raised lines, while the tuff in the intervening spaces has been disintegrated and carried away. On the ridges and peaks of several tuff mountains the surface is, as it were, pock-marked with numerous small irregular hollows, channels and pot-holes which are probably due to the combined action of water and drifting sand. There are often a great number of clefts and fissures in the tuff-mountains which can sometimes be seen from a great distance because of the plant-growth which retreats to them to find shelter from the storm. On the whole the varied forms of surface in the tuff districts greatly influence the details of the distribution of the plants of the place.

As tuff is far more easily decomposed than basalt, soil is formed more quickly upon tuff-mountains in cases where external factors such as sand-drifts and storms do not interfere. Therefore on the tuff and breccia mountains of southern Iceland there is a thick coating of soil and a luxuriant plant-growth right to the verge of the mountain; this is rarely the case on basalt mountains. Even on steep mountain-sides of tuff and breccia there exists a luxuriant vegetation of various species. This is especially conspicuous in Mýrdalur (south of Mýrdalsjökull) where, for instance, the extreme point of Reynisfjall is densely covered with plants. A luxuriant vegetation is also found in Víkurklettur and in several other places. On the whole, as mentioned above, it is characteristic of the lower mountains, south of the great Jökulls, to be covered by a comparatively luxuriant plant-growth, while the level country is barren, owing to the destructive action of the glacier-rivers. In the case of the sea-fowl cliffs, where manure is supplied by the sea-fowl, such tuff-mountains are far more densely covered with *Cochlearia*, *Archangelica*, etc., than are the basalt mountains.

In Iceland all which lies above 500 metres is a complete desert; this is also true of great parts of all that lies between 300 and 500 metres; at this altitude there are, however, rather extensive bogs covered with *Carices* and *Eriophorum*, especially towards the west (N. W. of Langjökull). Larger and smaller desert-areas are also found lower down; in some places they extend even to the sea, but in such cases they owe their origin to special circumstances — the destructive influence of glacier-rivers, volcanic eruptions or blown sand. In many inhabited districts the greater part of the surface consists of a rocky flat with scanty vegetation; a dense plant-growth such as that found in meadows, bogs and heather-moors covers only a very small part of the entire surface of the island, perhaps not more than 1500—2000 square km.; but the amount so covered cannot be stated with any certainty. The interior plateau owing to its height above sea-level and its climatic conditions will probably never be of any greater importance, as regards the livelihood of the inhabitants, than it is at the present time. Considerable tracts of the lower-lying parts of the plateau (afrijettir), in spite of the very poor herbage, are used as summer-pastures for the hardy Icelandic sheep which are driven up into the mountains about the end of June and fetched home again in the middle of September. No small percentage, however, of these sheep perishes yearly by venturing too far into grassless wastes, falling into rivers and down clefts, being overcome by snow-storms, becoming a prey to foxes, etc.

The snow-line and the glaciers form the upper limit of plant-growth; but from thence down to about 500 metres above sea-level, individual plants usually occur widely separated; there are, therefore, virtually no habitations on the plateau. As the height of the snow-line in the different parts of the island varies greatly, so similar laws govern the occurrence of the habitations, which are closely associated with the plant-growth. The highest snow-line occurs in north-east Iceland, and there the habitations also extend furthest upwards. Three parishes are found on the plateau itself, viz. Mývatnssveit at 300 metres above sea-level, Fjallasveit at 400—500 metres, and Jökuldalsheiði at 500—530 metres. In the last two the number of the farmsteads and of the people has been subject to very great fluctuations. The inhabitants of these parishes maintain themselves almost entirely by sheep-rearing. In Mývatnssveit the conditions are however more favourable, as it is situated at a

lower level, is sheltered by several high mountains and has moreover a rich fishery in Mývatn. The district of Fjallasveit is chiefly covered with blown sand, and the plants growing on the sand-dunes and sandy flats, viz. *Elymus arenarius*, *Salix glauca* and *S. lanata* and *Carex incurva*, serve as fodder for the sheep, which thrive well. These plants are cut and gathered during autumn for winter-use. It is, however, difficult to keep cows; and on account of the weather, neither potatoes nor root-crops will thrive. The climate is also far more severe than at the coast; the annual mean temperature in Mödrudalur is -0.8° C. In these districts the snow-line has a height of 1300—1400 metres above sea-level, and the highest limit at which habitations occur is 530 metres. On the north-western peninsula, to the extreme north the habitation-limit occurs at only 80 metres above sea-level, and the snow-line at 400 metres; more to the south, on the same peninsula, at about 130 metres, and the snow-line at 650 metres. For comparison with the height of the snow-lines given above I give in the following pages a list of the inhabited farmsteads situated at the highest levels in the different parts of the country, because they give an indication of the limit of the more densely plant-covered, inhabited country upwards towards the wide expanses, poor in plant-life, in the interior. The settlements in the uppermost valleys and in some parts of the plateau are by no means fixed; in years when severe weather occurs, with cold and damp summers, some of these farmsteads are abandoned, but are again inhabited when more favourable weather sets in. The areas above the populated districts, between these and the desert proper, are too poor in plant-life to be inhabited, but they are of great importance as summer-pastures for sheep and ponies.

Heights of the uppermost farmsteads above sea-level in metres.

Upon the northwestern peninsula.

Smidjuvík SE. of Cape Nord.....	80 metres
Skógar in Mosdal at Arnarfjörður....	82 —
Hlidarsel at Steingrímsfjörður.....	128 —

Near Faxaflói.

Fornihvammur in Nordurárdal.....	170 metres
Gilsbakki in Hvítársíða.....	175 —
Fljótstunga	232 —
Kalmannstunga	218 —
Hæll in Flókadal.....	174 —

Upon the peninsula of Reykjanes and in its immediate neighbourhood.

Vigdísarvellir NE. of Krisuvík.....	122	metres
Kolvidarhóll ¹ , near Hengill.....	262	—
Nesjavellir S. of Thingvallavatn.....	172	—
Svartagil N. of the above lake.....	182	—

Near the Southern Lowland.

Austurhlid on the way to Geysir....	163	metres
Haukadalur N. of Geysir.....	104	—
Tungufell S. of Gullfoss.....	148	—
Stórinúpur in Hreppar.....	135	—
Galtalækur W. of Hekla.....	142	—
Selsund SW. of Hekla.....	155	—
Raudnefsstaðir NW. of Tindfjallajökull.	239	—
Barkarstaðir in Fljótshlid.....	134	—

South of Mýrdalsjökull and Vatnajökull.

Höfðabrekka in Mýrdalur.....	128	metres
Svartinúpur in Skaptártunga.....	273	—
Holt in Sida.....	172	—
Eintúnaháls in Sida.....	227	—
Skaptafell (Bólta) in Öræfi.....	161	—
Viðdalur in Lón ² E. of Vatnajökull..	439	—

In the valleys of East Iceland.

M'rar in Skriðdal.....	183	metres
Kleif in Fljótsdal.....	126	—
Hákonarstaðir on Jökuldalur.....	310	—
Hauksstaðir in Vopnafjörður.....	195	—

Upon the plateau between Jökuldalur and Bárdardalur.

Viðirhóll on Jökuldalsheidi.....	533	metres
Lón.....	531	—
Möðrudalur on Möðrudalsfjöll.....	469	—
Viðdalur.....	462	—
Grímsstaðir.....	432	—
Viðirhóll.....	415	—
Reykjahlid at Mývatn.....	292	—
Gautlönd.....	279	—
Krákárþakki.....	363	—
Svartárbót.....	409	—

In the valleys of North Iceland.

Ishóll in Bárdardalur.....	368	metres
Reykir in Fnjóskadal.....	223	—
Tjarnir in Eyjafjörður.....	223	—
Bakkasel in Öxnadalur.....	350	—
Gilhagi in Skagafjörður.....	227	—
Mardargnuppsel at Svínadalur.....	395	—

¹ In reality only an inn for travellers.

² Not built until 1840; abandoned in 1842—1882; rebuilt 1883.

The surface of the interior plateau, with the exception of the glacier-covered areas, consists of deserts of stones, lava, gravel and blown sand. Where the underlying rock is basalt, the surface of the plateau is usually strewn with angular blocks of basalt, often in irregular heaps. Occasionally ridges are found, covered with gravel and blocks of glacial origin, but blocks split by frost are decidedly the more frequent upon these ridges. On the plateaus above the fjord districts of East Iceland, extensive areas are covered with angular blocks of basalt, but usually this layer of loose blocks is relatively thin. Similar conditions are met with in the north-western peninsula and on the mountains of North Iceland; but in the interior of the country glacial materials and the more recent formations preponderate. In that part, therefore, the greater part of the area consists of ice-striated ridges of dolerite, post-Glacial lavas, old bottom moraines and blown sand. Ice-striated streams of old dolerite-lava occupy vast areas in the interior. North of the great Jökulls the dolerite lavas may be traced continuously from Arnarvatn in the west to Snæfell in the east. Here and there the dolerite is covered with recent lava, and the closer the Jökulls are approached the thicker becomes the surface-layer of glacial gravel. As already mentioned, these monotonous, bluish-grey, stony deserts present an extremely desolate appearance. The only points upon which the eye can linger are scattered snow-drifts and large erratic blocks lying scattered upon the ridges. The landscape has undoubtedly remained for centuries unaltered in appearance; it must have looked as it does now, immediately after the snow-fields of the Ice Age had retired. There is no sign of life, and deep silence reigns over the land. The dolerite ridges, as has been already said, are covered with blocks rent by frost between which ice-striated domes protrude here and there. All the upper faces of the stones are dully polished and seamed by wind-abrasion. For days the traveller may see nothing else but gravel and ridges of rocks in endless succession like waves upon the sea; while as regards plants, only at intervals of 10 to 20 metres may a few stunted specimens of *Armeria maritima*, *Salix herbacea* and *Cerastium alpinum* be met with; the first-mentioned plant occurs most frequently. Here and there partially dried-up water courses and river-beds are found which are filled during the thaws of spring; and pools and small lakes are also occasionally met with hidden away in the low-lying ground between the ridges. In the immediate neighbourhood of the Jökulls,

where numerous glacier-rivers branch out upon the plateau, there are flats of rolled gravel and clay which are sometimes so steeped in water from the melting glaciers that they cannot be traversed.

On the interior plateau large areas (about 6500 square km.) are occupied by lava-streams — usually sheet-lava, with intervening tracts of slaggy lava. These lava-deserts are very poor in plant-life, and in the most highly-situated districts, they are almost entirely destitute of vegetation. Water is also very scarce, as the rain-water and the melting snow from the snow-drifts penetrate into the lava and do not reappear until far away as springs. The surface of these deserts consists of a hard, stiffened stony mass without a vestige of soil-covering, the hollows often filled with volcanic ashes and blown sand. The vegetation upon the lava-streams differs greatly on the plateau from what is found in the low-lying district, even if the lava-streams are of the same age; in the latter locality the oldest post-glacial lava-streams are often covered by a thick layer of soil, supporting heather-moors and coppice-woods; while on the plateau, lavas of the same age are quite bare. From Trölladyngja, a volcano in Odáðahraun, an enormous lava-stream (Frambruni), 110 km. in length, has flowed down through Bárðardalur to Ullarfoss. Up at the volcano itself the lava, to a height of 1000 metres above sea-level, is entirely destitute of vegetation; lower down from Dyngjufjöll to Bárðardalur (800—200 metres), the vegetation becomes denser each step. The blown sand which has accumulated in the low-lying tracts, is here and there covered with lyme grass, which is soon followed by dwarf willows and heather. Down in Bárðardalur (160—100 metres) the lava is entirely covered with greensward and river-gravel so that only a few lava-peaks protrude. Near Lundabrekka a rather thick layer of peat is formed on the surface of the lava; otherwise the large lava-waste of Odáðahraun (600—1200 metres) is almost destitute of plant-growth. The few plants which occur are especially met with where hollows in the low-lying tracts are filled with blown sand; most frequently some tufts of *Elymus arenarius* can be seen, and here and there a few specimens of *Silene maritima*, *Cerastium alpinum* and *Armeria maritima*. In places where the mountain streams from Dyngjufjöll have carried down a little clay, soil-formation has taken place to a small extent and extremely small specimens of *Salix herbacea* and *Polygonum viviparum* exist there. Lichens, which occur so frequently on low-lying lava-streams, are very rarely met with on Odáðahraun, so the lava-surface is usually

quite destitute of covering; on the other hand, on lava-streams near Mývatn (above 300 metres above sea-level) lichens are very frequent. There, many species of phanerogams have also made their appearance, and both there and in Kelduhverfi the lava is often found to be covered by a thick carpet of moss. On Reykjanes scores of square km. of lava are entirely hidden beneath a soft greyish carpet of *Grimmias*.

Between Jökulsá á Fjöllum and Jökulsá á Brú, and between Kaldakvist and Skaftá, more recent tuffs appear upon the surface of very considerable tracts of the plateau, not covered by ice-striated dolerite-lavas or by modern, basaltic lavas. Where this tuff does not appear as bare peaks or steep mountain-chains, the surface is covered by lava-gravel disintegrated from the breccia, or else it is covered by blown sand, which is widely distributed, not only on the interior plateau but also in the lowlands. Blown sand is of varied quality and origin. It may be coarse or finer; it is sometimes so fine that it penetrates everywhere. During violent storms in sandy districts the fine dust is carried to the most remote quarters of the island and is deposited as a fine layer all over the surface: it even falls on vessels in mid-Atlantic. But naturally most dust falls in districts bordering on the tuff-belt or situated in it, as the dust chiefly originates from the tuff. The atmosphere in distant regions is often yellowish-brown because of the fine dust suspended in the air, and this dust-cloud is known in Iceland as "mistur." This tuff-dust has played a very important part in the formation of the Icelandic soil and subsoil, and it can be demonstrated almost everywhere. In the blown-sand districts proper, and in the neighbouring regions, where also larger particles of stone are put into motion, wind-blown sand has a great mechanical influence and is a mighty geological factor; its denudating effect upon the tuff mountains has been very great. Harder rocks are also affected by the sand: dolerites acquire a dull polish with irregular depressions, striations and furrows, while basalt is likewise sand-polished though to a less extent. Tuff and breccia mountains are always more highly disintegrated on the windward side, and the isolated fragments of basalt embedded in the breccia project further from the ground-mass on that side than to leeward. When the wind is stormy, great masses of blown sand are constantly driven through the narrow valleys, which occur between the numerous sharp tuff-ridges east of Túngná, so that no vegetation can thrive there; only here and

there upon the highest ridges and peaks, which cannot be reached by the coarser grains of the drifting sand, are seen small patches of soil supporting mosses and a few phanerogams.

In Iceland blown sand consists almost invariably of decomposed volcanic rocks: quartz-sand does not occur in Iceland. The most common blown sand is palagonite-dust usually of a yellowish-brown colour, which when examined microscopically, is seen to consist of glass-particles, tachylite, palagonite, plagioclase, augite and various



Fig. 15. Móhella in Króksdalur, not far from Sandmúladalssá. (Phot. Heinrich Erkes.)

finely decomposed zeolitic alteration-products. Volcanic ashes of recent date often occur as blown sand especially in the interior of the lava-wastes: they are heavier and less mobile, consequently, they are not dispersed in quantities beyond the volcanic districts. In the neighbourhood of the great glacier-bearing mountains, considerable tracts of level land are often covered with glacial clay, which when dried, crumbles into dust and drifts beyond the nearer surroundings. Around Dyngjufjöll, especially south-east of Askja, large areas are covered with blown sand, consisting of liparitic pumice-dust which all dates from the eruption of 1875. Moreover, stretches of blown sand consisting of decomposed mussel shells, i. e. calcareous dust, occur here and there along the coast of the north-western peninsula.

Owing to the variability of the wind-conditions, the dunes in the blown-sand districts are usually small and irregular in form; they are rarely higher than 3—4 metres, usually much less, and they are bound together by lyme grass and a few creeping dwarf willows. Sandy levels with low waves of sand are of general occurrence, and when moisture comes into play, the surface is cracked into numerous polygonal cakes by the action of desiccation or frost. The cracks are filled with drifted sand, so that the surface resembles a kind of mosaic.



Fig. 16. Soil torn up by the wind. Large tracts in Landsveit are occupied by these loess-like formations. Here several square miles of land, which were formerly wood-covered, are torn up by the north-east wind. The district of Landsveit, west of Hekla. (Phot. Th. Thoróddsen.)

In tuff districts proper older and younger æolian formations are the thickest and most widely distributed, and often alternate with volcanic and glacial formations; but the tuff-dust is also carried to the basalt districts, where they initiate the formation of the loess-like layers known in Iceland as “móhella.” Smaller layers of “móhella” occur everywhere in valleys and lowlands alternating with older and more recent glacial formations, with peat and lava-streams, but they decrease in thickness the further they are away from the large stretches of blown sand in the tuff districts. “Móhella” usually resembles a fine, easily crumbled, yellowish-brown or grey tuff, which is often traversed by stems of plants and red tuff-tubes which have been formed around the decayed stems; they

often alternate with layers of wind-polished stones, gravel, scoriæ or pumice, sometimes with clay. Where the blown sand is continuously moving, no vegetation can thrive, but when the fine dust and sand has blown away as far down as to the coarse gravel, Icelanders say that the sand is "örfoka," i. e. it cannot drift any longer (see Fig. 14). Then plants are again able to take root and new soil is gradually formed — until that also is blown away. The phenomenon of alternating periods of sand-drift and of vegetation, which has lasted through centuries, is nowhere so distinctly traceable as in Rangárvellir. Here the substratum is exclusively formed by "móhella," the thickness of which is unknown, but it must be considerable, probably 100 metres or more. Here the lowland plain abuts on the lava-fields of Hekla, whence quantities of volcanic ashes are blown down into the cultivated land. The lowland plain is intersected by deep, branching valleys, which are usually dry, but during the thaws of winter and spring large quantities of water have an outlet through these channels. From the plain a series of small terraces leads down to the bottom of these valleys, which often consists of a grass-covered, level stretch of land. The valley-sides offer favourable opportunities for studying the composition of the móhella: fine bluish-grey layers of sand alternate with reddish sand-layers penetrated by compounds of iron, and the embedded stones of varying sizes bear testimony to the strong erosive action of blown sand. In some layers soil and remains of plants occur, also clay-tubes formed around haulms of grasses. Here and there layers of pumice and scoriæ are also seen. No inhabited district at the present time is so exposed to being attacked and overwhelmed by blown sand as Landsveit in the southern lowlands. Here, during the nineteenth century, large stretches of grassland and many farmsteads were overwhelmed by drifting sand, especially in the years 1836 and 1880—1881. The substratum consists of old lava which formerly had a covering of móhella and greensward, now to a great extent torn up and destroyed by the masses of blown sand from the north-east. Sand storms cause deep channels and furrows in the soil, which constantly enlarge and by combining with others, gradually destroy the entire layer of soil, so that only a few massive fragments of móhella with hollowed sides and covered with greensward traversed by the fibres of plants, are left behind until they also succumb to the universal destruction. In large stretches of this district all greensward and soil have been torn off down to the naked lava-rock.

From here proceed broad, ramified channels containing blown sand, which are continued and widened, and which constantly encroach on the remaining piece of grassland. The north-eastern part of this district was formerly covered with heather and coppice wood, which the inhabitants, with incomprehensible lack of foresight, destroyed and used for fuel. Skarðsfjall, which stands in the centre of Land-veit, has protected the areas situated in its shelter towards the south-west. Some streams have also checked the advance of the drifting sand and have thus acted as a protection. Most of the blown sand which in various ways devastates the cultivated districts, originates from the wastes of the plateau. There is indeed enough and to spare of it, at least 3—4 thousand square km. of the interior being covered by blown sand of various thickness. On the plateau the blown-sand tracts appear rarely or never to become "örfoka," therefore they are almost always quite bare of vegetation with the exception of the scattered tufts of lyme grass and a few small willows in more favourable localities. In the elevated districts, the surface of which we have been describing, many plants cannot be expected to thrive. As we shall have occasion to mention later on, the highest part of the interior of Iceland, at a height of 650—1000 metres, is a waste extremely poor in plant-life.

The lowlands, as mentioned above, cover only a very small area ($\frac{1}{15}$) of the entire surface of Iceland; and a considerable part of this small area consists moreover of barren soil, of lava-streams, of stony rocks and ridges poor in plant-life, and of glacial and blown sand. Therefore the area which may properly be regarded as densely covered with plants, is very small compared with the entire area of the country, and with the present method of cultivation it could scarcely maintain the rural population if the mountains and parts of the plateau could not be utilized as pastures for sheep during the summer. The extent of plant-distribution differs, however, greatly in the different parts of the lowlands. While some of the districts are almost entirely or for the greater part covered by a dense vegetation of grass, sedges, heather or coppice-wood, as Ölfus, Flói, Skeið, Landeyjar, Mýrdalur, etc., great parts of other inhabited districts have not even half of their area grass-covered. Several inhabited areas in Skaftafellssýsla, Mulasýslur and Thingeyjarsýslur contain very large tracts of rocky flats, poor in plant-life, lava-streams, sandy wastes, etc.; and in some districts only a very small fraction of the surface is of any use for the sheep- and

cattle-rearing of the rural population. The peninsula of Reykjanes, which is of no great elevation, more than half of its surface being below 100 metres, and which has a comparatively mild climate with a considerable rainfall, is, however, so poor in plant-life, that only 4 per cent of the area is grass-covered. The area bounded on the west by Lágaskarð and on the south by Hafnarfjörður is about 1635 square km., but of this only at most 69 km. is occupied by grassland. The greater part of the area of the peninsula of Reykjanes is covered by more recent lava-streams, and has a scanty vegetation; the inhabitants along the coast maintain themselves chiefly by fishing.

As it has already been remarked, the surface of the lowlands varies in character. It usually consists of loose masses, but sometimes also of solid rock which projects here and there through the more recent formations and the older and more recent lava-streams, as crests, ridges and hills. As mentioned above, in South Iceland large areas (2000—3000 square km.) are covered with glacial and volcanic sand, through which branching glacier-rivers flow. Although these sandy tracts originate mainly from river-gravel and sand, other constituents are also found intermixed in them, for instance tuff-dust, and volcanic scoriæ and ashes, where active volcanoes occur in the neighbourhood. On Mýrdalssandur volcanic slags and ashes predominate. River-gravel and glacial clay occur only upon the surface of changing river-beds. The vast Skeiðarársandur, on the other hand, is formed almost exclusively of rolled glacial-gravel mingled with fine sand and clay, which increases in amount the nearer the coast is approached. The various sandy tracts differ naturally somewhat as regards the quality of the material and the size of the grains, etc. Old lava-streams, also, extend over large areas of the lowlands; they are usually covered with soil which supports a luxuriant vegetation with heather-moors, coppice-woods and grasslands. In thickly inhabited districts such as Flói and Skeið, the substratum is of lava, and in the former district it is marshy, as it lies so low (at the level of the sea), that the water cannot drain off. Flói is jammed in between two river-deltas so that the rain-water cannot be drained away owing to the pressure of the bottom water, and in rainy years this district suffers greatly from water which has no outlet, so that the ground is quite boggy. The underlying lava protrudes from every hill and the soil is mixed with lava-fragments. The lowland tract of Flói gradually merges into the district of Skeið which

is situated upon the same lava-stream, but as the level above the sea is somewhat higher, the water most frequently penetrates into the lava, and the soil is sandy, hard and dry and covered with a good and vigorous growth of grass. The sedges disappear or retreat to small patches where the local conditions allow the accumulation of a greater amount of moisture. The thicker soil-layers upon the lava-streams, usually originate from tuff-dust (*móhella*), which has been carried thither and has gradually filled up all the depressions, and from glacial clay deposited by rivers. Several lava-streams with a thinner layer of soil support coppice woods — e. g. on Thingvallahraun, and Hvítárhraun — and heather, as on Reykjaheiði near Kelduhverfi, and others. In the lowlands the quantity of the plant-growth upon the lava-streams is closely connected with their age, and by the end of a century, a number of species has already settled down on a lava-stream, as may easily be seen upon the Skaftá-lavas of 1783 and the Leirhnúk-lavas of 1724—30; on the other hand, the lava-streams of Sveinagjá, which date from 1875, are still very poor in phanerogams.

In the most thickly inhabited districts the substratum of the soil generally consists of older and more recent glacial and alluvial formations, very often in connection with "*móhella*," volcanic ashes and lava-gravel. In the lowlands, which were covered by the sea at the close of the Glacial period, marine sand and clay layers are most frequently found immediately upon the basal rock. The clay, which was deposited by the glacial rivers of the Ice Age, often occurs in layers of considerable thickness; it is most frequently bluish-grey in colour and turns blackish-blue on being wetted; it is very tough and dense, and can often become rather hard. The clay contains a very insignificant amount of carbonate of lime, usually only 0.1—0.2 per cent, while the Danish Yoldia-clay, according to Johnstrup, contains 5—15 per cent of carbonate of lime. Along the rivers the banks of clay may often be traced for several kilometres without any disturbance being observed in the position of the layers, which is extremely regular and nearly always horizontal. The thickness of the clay-formations varies greatly; in the most highly situated parts of the lowland area and in the valleys, it is sometimes as much as 20—30 metres, further down from 5 to 15 metres. The thickness diminishes the nearer the coast is approached; but it may vary greatly. The clay occurs not only where rivers cut through, but also as a substratum below morasses. Marine sand

often occurs above the clay, and then more recent river-deposits, alternating with móhella, volcanic gravel, etc. Here and there, these formations are exposed at the surface and form an almost barren gravelly flat (melar), which, far into spring, is quite slushy, owing to the melting snow, which cannot drain away on account of the sub-surface ice and the clayey subsoil. In the eastern part of the southern lowland tract, under the boggy ground, occur enormous river-deposits (Landeyjar) — delta formations from Markarfljót and other rivers. But higher up, where the soil is drier (Rangárvellir), the subsoil is composed of thick móhella-formations; nearer to the sea occur fine sand and downs.

In several districts in the lowlands there are a great many rocky ridges (holt), which protrude through the morasses and grass-land. They vary in nature according to the character of the underlying rock, and generally consist of basalt or dolerite, rarely of palagonite-breccia. These ridges usually bear clear evidence of the action of the glaciers during the Ice Age. They are highly ice-striated and often have two distinct sides, one bearing traces of having been exposed to the direct force of the ice, while the leeward side is comparatively destitute of such marks. Their external form is sometimes dependent upon the direction of the inclination of the basalt-layers. In some places (Mýrar and Breidifjörður) they originate from fragments of a deeply sunk basal rock. The surface is usually stony, with solid rocks, larger loose stones, and smaller gravel; sometimes a great many erratic blocks are scattered upon the ridges. As regards plant-growth, these ridges should be characterized as rocky flats more or less covered with vegetation, and protruding like small islands above the grass-covered, usually boggy level lands. In several places the ridges, in olden times, have been clothed with coppice woods, but it is centuries since the coppice has been destroyed by sheep and goats. Such ridges are found scattered over a great part of the island in the lowlands and valleys, and often impart a characteristic feature to the landscape. The farm-buildings are often built upon them. In the low-lying marshy land of Mýrar, at the edge of Faxaflói, they occur scattered in hundreds in the bogs, and in the southern lowland district they are frequent in the eastern part of Flói and the upper part of Holt, while elsewhere large stretches of this lowland area are completely flat. In other districts they are so large that they are most properly described as small mountains (fell, hálsar). In the valleys the old moraines are often trans-

formed by the rivers, and converted into terraces, which form the substratum of bogs and grassland. The glacial moraine-gravel often extends far up the mountain-sides and forms here a substratum for soil and plant-growth. In other places in the valleys are steep rock-faces, stony slopes, heaps of large fragments of rock (urd), and the conical heaps of finer and coarser gravel brought down by the mountain-streams, which all help to give variety to the plant-formations. While basalt-mountains are slightly and slowly disintegrated, tuff-mountains are extremely liable to disintegration, hence the products of the latter, combined with the action of wind, glaciers and rivers, play a more important part. The contribution of the basalt towards soil-formation dates mainly from the Glacial period. As we have seen from the above, the substrata which support plant-growth are (1) firm ground, having a rocky base (basalt, liparite, breccia and lava); (2) loose soil, consisting of moraines, river-gravel, sand, clay, blown sand, volcanic ashes and tuff-dust (móhella); and (3) the products of the plants themselves: boggy soil composed of peat and humus.

The character of the subsoil below the humus-layer and the plant-covering is consequently in close relation to the chemical and mineralogical composition of the underlying rock. Over the greater part of Iceland the inorganic soil consists of decomposed basaltic rocks, the main mineralogical constituents of which are plagioclase (especially lime-felspars) and augite, but magnetite and olivine also occur, often in great quantities, and apatite and a small quantity of titanite iron. The chemical composition of the Icelandic basalts is rather uniform. On an average they contain 43—53 % of silica, 11—18 % of alumina, 11—22 % of iron (Fe O and $\text{Fe}_2 \text{O}_3$), 8—13 % of lime, 2—9 % of magnesia, 0.2—2 % of potash and 1—4 % of soda. Because anorthite, of the plagioclases, is very largely distributed in the Icelandic rocks, not only in the basalt, but also in the recent lavas and tuffs, these Icelandic rocks often contain a comparatively small amount of silica and a very considerable amount of lime and also alumina. The reason why the Icelandic soil is nevertheless poor in carbonate of lime may be found in the fact that the lime can only with difficulty be separated from its siliceous compounds, and because in the whole of the island, no sedimentary calcareous rocks are found, though such are of common occurrence in other countries. In districts where sulphurous acids sent out from fumaroles have affected the rocks, as is common in tuff-districts,

calcium sulphate (gypsum) is very common in the soil. The Icelandic basalts have not been investigated with regard to the amount of apatite contained in them, but judging from the abundance of phosphoric acid which often occurs in the waters of the large rivers, it must, in some places, be very considerable. In the districts where liparite is the main rock, the soil has not yet been investigated, but it must vary somewhat, on account of the varying composition of the rock, which contains much larger amounts of silica (65—78 %), potash (2—4 %), and soda (3—6 %) than the basalts. For the rest, the Icelandic liparites show evidence of their connection with the basalt-area in which they occur, by the fact that almost all of them are soda-liparites.

From Iceland there are as yet only a few soil-analyses to hand, and from a few districts only.¹ In calcined samples of fine soil from dry grasslands the main mass consisted of silica (37—48 %), alumina and peroxide of iron (38—50 %), while lime, magnesia, alkalis, present as silicates and other compounds, were found in quantities of from 7 to 14 %. The amount of carbonate of lime was but small, and varied from 0.5 to 1.7 %; in home-fields most frequently 1.5—1.7 %. On the other hand, the amount of phosphoric acid was larger (0.3—0.4 %) than in ordinary Danish soil. The soil samples were rich in humus and contained an unusually large amount of nitrogen considering the amount of humus — from 7 % to as much as 24 %. The amount of humus and also of iron compounds is larger than in ordinary Danish soil. Under unfavourable conditions of humidity the abundance of the organic substance found in the soil constitutes a danger, on account of the formation of protoxide of iron; and climatic conditions make the chemical changes in the materials of the Icelandic soil difficult and slow in wet tracts. The amount of the inorganic substances in the sand-samples gives a correct idea of the chemical composition of the solid basaltic rock.

Some analyses have been made of Icelandic plants. Firstly, of Icelandic hay, both hay from home-fields (tun; see Fig. 17) and hay from dry and from wet meadows. The analyses show that the Icelandic hay resembles mountain hay from the Alps. It contains a larger amount of fat than does the Danish hay; less cellulose;

¹ Analyses of Icelandic soil are found in P. Feilberg: *Bemærkninger om Jordbund og Klima paa Island* (Tidsskrift for Landøkonomi, 1881) and by A. Torfason in *Búnaðarrit*, Reykjavík, XX (1906), pp. 173—184; XXIII (1909), pp. 52—54. Also, in the recently published work by M. Gruner: *Die Bodenkultur Islands*, Berlin, 1912.

and a larger amount of ash.¹ Afterwards, many different species of plants were analyzed and compared with Swedish plants and the main result arrived at was very similar.² P. Feilberg writes: "Iceland is the land of the Cyperaceæ and of the coarser species of grass, but the sheep and the cattle which through generations have accustomed themselves to this coarse food, thrive well on it. The chemical contents of the fodder show that this is also possible, nor is there any reason why it should be otherwise."

In a damp and cold climate such as the Icelandic, the chemical changes in the material of the soil take place more slowly than the formation of vegetable matter, which accumulates and absorbs water where this is copiously present; thus the entrance of air is prevented, and heat is not generated. These circumstances give rise to the production of acid, boggy humus as in other northern countries with a cold and damp climate. Considerable areas in Iceland are covered with boggy soil, and there are also the very best conditions for the formation of peat and bogs. In some parts of the lowlands there are vast extents of bogs and swamps, as e. g. in Mýrar and Andakill at the head of Faxaflói, and in Flói, Ölfus, Holt, etc. in the southern lowland tract; while larger and smaller swampy areas are found almost everywhere. In the lower-lying parts of the plateau there are also wide stretches of boggy land, e. g. Tvídægri, north-east of Langjökull; Miklumýrar, north of Hreppar, and many other places. In the majority of the districts the area of wet grassland, covered with Cyperaceæ and mosses, exceeds by far that of the dry grassland, but unfortunately as yet no measurements are to hand as regards the extent of the bogs.³

There are considerable peat-formations in the Icelandic bogs, but their thickness, distribution, plant-remains, etc. have not yet been investigated. In Skaftafellssýssel where glacier-rivers and volcanic

¹ Josep J. Björnsson: Um heygæði (Thjóðólfur, 1886, No. 40). P. Feilberg: Græsbrug paa Island, Kbhavn., 1897, pp. 14—17.

² St. Stefánsson and H. G. Söderbaum: Isländska foder- och betesväxter (Meddelanden från kgl. Landbruks-Akademiens experimentalfält. Nos. 74 og 83, Stockholm, 1902 and 1904). Also in Búnaðarrit. XVI, 1902, pp. 179—196; XVII, 1903, pp. 25—66; XXIV, 1910, pp. 1—48.

³ M. Gruner's "Die Bodenkultur Islands," Berlin, 1912, came to my notice after I wrote the above; in it he estimates the entire bog area of Iceland at 10,000 square km. or about 10 % of the entire area of the island. According to this, as regards the extent of its bog area, Iceland is reckoned to be third among the Scandinavian countries: Finland 27.2 %, Sweden 12.6 %, Iceland 10 %, Denmark 5 % and Norway 3.7 %.

eruptions have constantly been influencing the soil-formation, peat is rare. In the peat there often occur quantities of stems, roots and branches of *Betula odorata*, and Francis J. Lewis¹ has found remains of *Betula verrucosa* in peat-bogs in South Iceland. Even in districts where birch-copses no longer thrive, as e. g. on Hornstrandir north of Jökulfirðir, birch-stems are found in the peat bogs. The Icelandic peat is largely utilized as fuel, and as regards its fuel-value it compares favourably with peat from other countries,² only the amount of ash is rather considerable, especially in peat from South Iceland, perhaps on account of the presence of volcanic ashes and blown sand. In the Icelandic peat-bogs there usually occur several, or a few, bands of volcanic ash of various thickness, usually basaltic ashes, but yellowish liparitic pumice-ash occurs also. In districts situated in the neighbourhood of active volcanoes the ash-bands in the bogs are very numerous. Bog iron-ore occurs also in the Icelandic bogs; in some places in rather considerable quantities. In olden times it was much used by the inhabitants, and for the smelting of the iron many coppice woods were destroyed. Parts of various boggy stretches — wet meadows — have great economic importance, and the hay (uthey) is largely used as fodder for sheep and cattle, especially as winter fodder for horses and sheep; the best part of it, only, is used for the cows, which live mainly upon hay from the home-fields (tun-hay). In 1910 about 14,300 tons (each ton 1000 kg.) of this uthey were harvested. Of the largest and most productive meadows of this kind may be mentioned Hvanneyri in the district of Borgarfjord, Forin in Ölfus and Safamýri in Holt. At the mouths of various large glacier-rivers are large and very fertile stretches of meadow-land, which either constantly or else at times are flooded by glacier water, e. g. in Lón in East Iceland, at Hvanneyri in Borgarfjord, and in several other places where a kind of marsh is formed by the deposited glacier-clay which contains fertilizing substances; in such places the river-water is no longer very cold, and has a very slight current or none at all. In water from Icelandic rivers the following substances of use for plant-food were found: the figures given are those for five million pounds of water (one pound = half kg.).³

¹ F. J. Lewis: Stratification of Peat Deposits in Iceland (Transactions of the Royal Society of Edinburgh, Vol. 47, Part IV (No. 26), Edinburgh, 1911, pp. 827—831).

² Analyses of Icelandic peat by A. Torfason are found in Eimreidin, XI (1905), pp. 40—41, and in Búnaðarrit, XX (1906), pp. 116—119.

³ The analyses are found in P. Feilberg: Græsbrug paa Island, 1897, p. 22;

	1 Danish Streams	2 Höngá	3 Eyjafljóðará	4 Hvítá (Borgarfjörð)	5 Laxá from Mývatn	6 Hvítá (Arnessysla)	7 Thjórsá	8 Thjórsá: during the thaw of 1898
Nitrogen	15-20	1.37	4.65	1.35	110.00	4.9-14.12	4.5- 6.5	3
Potash	10-15	13.50	11.50	11.00	15.50	12.5-17.5	11.0-15.5	140
Phosph. acid.	0.6-1.0	1.05	5.00	4.35	35.00	1.5- 3.5	5.6-19.5	157
Lime.....	100-700	33.02	35.00	41.50	55.00	21-37	49-82	46

In several places river-water is utilized for irrigation, and irrigated meadow-lands were calculated to cover an area of 28.4 square kilometres in 1909.

The only cultivated soil in Iceland is that of home-fields (tun) around the farm-buildings. These home-fields are manured and levelled, but generally are not ploughed. The extent of the cultivated areas (tunes) of the whole of Iceland was in 1909 calculated to be 187.8 square kilometres; to this should be added 2.8 sq. km. for the cabbage and potato plots. There are often numerous knolls in the tunes, which render haymaking very difficult (Fig. 17). Therefore the improvement of the soil consists in the levelling of these knolls, which, however, reappear in several places after a time. The nature of the tunes and the quality of the soil naturally differ greatly according to cultivation and situation. The grass (tada) from the tunes consists mainly of Gramineæ, and, as already mentioned, is used as winter fodder for the cows. In 1910, 5145 tons of tun-hay (tada) were cut. Outside the home-fields there is also a great deal of dry grassland (harðvelli) covered with Gramineæ, which is chiefly used as pasture-land for sheep and cattle. In the soil of the tunes and the dry grassland a larger quantity of lime and phosphoric acid is usually found than in that of the wet meadow-tracts.¹

As in other arctic and subarctic regions, "soil-flows" (Solifluktion) are a common phenomenon in Iceland, and they exercise, especially in mountainous regions, no slight influence upon the soil and plant-growth. The upper layer of the soil upon slopes and

and in Búnaðarrit, XXII, 1908, pp. 265 and 266. No. 1 is by Feilberg and Westermann, Nos. 2, 3, 4, 5 and 8 by Detlefsen and Meyer; Nos. 6 and 7 by A. Torfason. Nos. 5 and 8 appear somewhat doubtful.

¹ P. Feilberg in Tidsskrift for Landøkonomi, 1881, pp. 8-12.

mountains-sides is saturated with water from melting snow during spring, and slides slowly downwards; very often gravel and clay is by this arranged in bands down the slopes. Below large snow-drifts which persist till far into summer, or during the whole of summer, there is always water which soaks into the soil, and upon many mountain-sides, slow-flowing mud-streams are formed, which in shape and movement recall small glaciers. In other places the flowing



Fig. 17. An old Tun. Kjós near Reykjavík. (Phot. A. Hesselbo.)

soil forms small terraces, which are partially transformed into rows of knolls overgrown with plants. Sometimes the soil is loosened from the solid rock, or slides upon the ice of the subsoil; sometimes clayey streams flow down into depressions and valleys, and occasionally fragments of greensward, which had been resting upon a saturated substratum of sand and clay, are loosened. Frequently it can also be seen how water, flowing upon the ice of the subsoil down the slope, undermines the soil so that large pieces of greensward are put into motion, give way, and are torn asunder. It may also happen, where there is a thick layer of loose soil, that eth

downward-flowing water, during thaw, tunnels below the ice-layer and forms subterranean channels, causing the upper layer to collapse and fall down into these hollows. In this way, after the volcanic eruptions of Askja in 1875, great damage was done to the soil on Jökuldalur; its enormous moraine-terraces were covered with pumice-gravel which froze into a thick layer that melted but slowly, because the white, glistening gravel reflected the rays of the sun; below this layer, the water dug out channels, 20—30 metres deep, through earth, sand and gravel, and caused catastrophes such as that mentioned above.

In this connection may be mentioned the influence often exerted upon the soil by the numerous avalanches and rock-slips of different kinds, and the very slow, creeping movement which may be observed in connection with gravel, stones and rocky blocks upon the mountain sides which, in the course of years, may become of very great morphological importance. During earthquakes it may happen that mountain-sides clad with grass and coppice are suddenly denuded of their surface soil, which slides down into the lowland plain. During the earthquake of 1896 a piece of swampy soil, 10,000 sq. metres in area and 2—3 metres thick, at Thjórsá in the neighbourhood of Krókur, thus slid down, being thrown into wavy folds and hummocks, although the slope of the ground was only $1-2^{\circ}$. The mountain of Skarðsfjall, which rises 227 metres above the plain, had, before the earthquake, a thick coating of soil, and was grass-covered to its verge; but after the earthquake it resembled a fruit which has been peeled. Thirteen landslips descended on the western side, leaving behind them large surface depressions, and strewing below mighty mounds of soil, clay, gravel and stones together with larger and smaller fragments of torn greensward. These landslips must, in the course of time, have had an enormous influence upon the soil and the plant-growth of many districts where earthquakes are very frequent. All over the island are often seen, along the mountain-sides, marks of ancient huge earth- and rock-slips that could only have occurred during earthquakes.

Level tracts with their surfaces cracked into polygonal cakes (rudemarks) are extremely common in Iceland, and fine specimens of such may be seen as, for instance, in the neighbouring districts of Reykjavík. They have a peculiar effect upon plant-distribution on the rocky flat. "Rudemarks" are usually formed only on flat land where the soil consists of gravelly clay — especially clay inter-

mixed with a large quantity of tuff-dust (móhella). The surface is divided into squares or more or less regularly formed polygons, by bands of small stones or gravel, while the clay of the interior of the squares or polygons is destitute of stones. The surface resembles a net — the meshes of which are formed by irregular bands of gravel. Usually it is only the gravel which supports plant-growth; there the plants can find shelter between the stones, while the middle of the clay-cakes is too wet for plant-growth. But when the “rudemark” becomes drier, vegetation may gradually extend over the

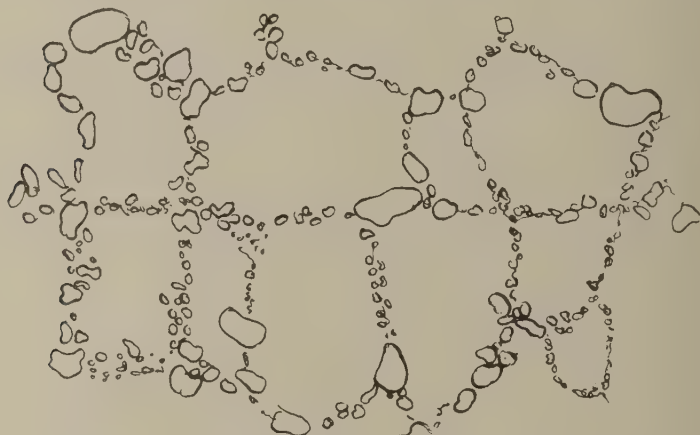


Fig. 18. Portion of a “rudemark” in the neighbourhood of Reykjavík, showing the position of the stone and gravel bands. (Drawn by Th. Thoroddsen.)

cakes of clay, first forming a scattered growth upon them and ultimately soil and a plant-carpet, especially when tuff-dust and drifted soil have settled on the surface. The polygonal cakes vary greatly in form and size, but generally they have a diameter of only $\frac{1}{2}$ —1 metre. The knolls (þúfa, pl. þúfur; see Fig. 17), which play such an important part with reference to Icelandic vegetation and agriculture, stand in close genetic relation to the “rudemarks” and we will therefore try to give an account of the way in which they both have probably originated, but questions bearing on this point require to be elucidated by the experimental investigations of persons living on the spot. My investigations in Iceland have confirmed me in my opinion that the Icelandic þúfur — as already mentioned — stand in a close genetic relation to the “rudemarks” and that sub-surface ice is an essential condition for the formation of both;

where for some reason or other no ice-layer is formed in the ground, neither "rudemarks" nor knolls seem to occur.

The depth at which this ice is present in spring differs greatly in the different parts of the island, and — according to the weather — in the different years. In the northernmost districts this ice may remain throughout the summer for years during cold and damp periods. As a rule, in the first half of June, frozen ground is met with at a depth of 1—1½ metres over the greater part of the island; on the plateau a thicker or thinner layer of this sub-surface ice is no doubt always present throughout the summer, and there, in several places, it gives rise to the formation of swamps, bogs and lakes, as the melting snow and ice cannot drain off. In some districts with very warm ground, where hot springs or other secondary effects of volcanoes occur, the ground is never frozen.

As is well-known clay and clay-soil develop, by contraction, numerous intersecting clefts; such cracks are also formed during winter by the action of frost, and in severe winters loud cracks are constantly being heard, announcing the rending of the ground. The surface layer of soil is therefore traversed by a network of numerous rents and cracks which divide the clay-soil into irregular fragments or a number of prisms. On closer investigation these cracks are not only found to occur on gravelly and clayey flats, poor in plants, but also in the clay-humus of the home-fields; some of them are as fine as hairs, others have a breadth of 2—3 cm. Both these factors, the sub-surface ice and the cracks in the ground, are necessary to the formation of "rudemarks" and knolls, and to these should be added two other very important factors, viz. frost and unequal surface-evaporation.

When, in spring, the snow melts on the cracked and netted surface of a flat consisting either of clayey gravel or of plant-covered clay-soil, and the flat itself thaws at the surface, the water percolates through the ground and the cracks, but cannot escape on account of the sub-surface ice so that the entire layer of soil becomes saturated with water. Where the flat consists exclusively of sand and gravel, without any mixture of clay, the entire soil-layer is evenly saturated and the surface of the water can sometimes rise to a level with that of the ground. Evaporation then takes place evenly over the entire surface, and when the sub-surface ice melts, the surface-water drains away or evaporates, and nothing further happens. But on a clayey gravel-flat intersected by a network of

cracks, the circumstances are somewhat different. During spring the ground is partially thawed; it freezes in the night and thaws during the day. The sub-surface ice forms a downward limit which does not permit the water to drain away, and uniform circulation and evaporation at the surface are prevented in a "rudemark" by ice-formation in the many cracks, originally full of water, which together with the sub-surface ice as a base form a vascular- or cell-system over the entire flat, and this system lasts at least for some time. The water from the melting snow and ice on the surface collects mainly in the cracks and depressions, where it freezes during the night; this is best observed on a knolly flat, which during the thaw of spring produces an entire network of small water-canals. The water cannot penetrate downwards on account of the ice in the cracks or, if they should be free from ice, it will yet remain for a long time in them, for as the water-layer is thicker there than upon the polygonal cakes, the evaporation is slower. The heating of the sun and consequent evaporation of water is therefore greater on the cakes, so that the wet from below, from the slowly thawing parts of the ground and the ice of the subsoil is drawn up into the centre of the cakes. A clayey soil with particles of a certain size has great capillary power and can absorb water and draw it up in great quantities.¹ The power of absorption of the clay-soil is greatly increased when it is covered by soil, humus and plant remains. During spring, frost and thaw alternate constantly and daily. The "rudemark" freezes in the night, at least partially, and thaws in the morning; in the course of the day the water rises in the individual clay-prisms owing to the rapid evaporation from the surface, but in the night it freezes, expands and raises the central part of the cake. This occasions a constant wandering of the particles of the clay soil upwards into each clay-prism, and by the constant pressure exerted by the frozen soil throughout a long period, the heavier particles are sorted out, and as they are less mobile, they are left behind or pushed to the sides. This sorting-out of the coarser material is the most characteristic feature of the "rudemark." The enormous pressure due to the freezing process is well known. As will be mentioned again later on, in several places in the Iceland mountain-bogs there are opportunities of observing how the frozen

¹ The air contained in sandy clays in a dry condition may amount to 40 % of their volume, and by infiltration, as large a volume of water may replace the air. See A. G. Högbom in *Geol. Föreläsning*, Stockholm, 1905, XXVII. p. 22.

water inside the knolls can rupture a greensward, 10—20 cm. thick, and traversed with plant-roots. This pressure from below, repeated for years in a "rudemark," must gradually push and force the gravel aside so that it lodges at last in the cracks which, while they are filled with ice, form a kind of wall around each clay-prism. Thus the stones are placed in the neutral territory between the small centres of power, and form a boundary to each cake, the upper edge of which boundary appears upon the surface while the lower reaches down to the ice in the subsoil. Below the level of this ice the gravel is irregularly dispersed in the clay; it is regularly arranged only in the surface-layer above the ice. In the summer, when the soil has thawed and the sub-surface ice melted, the water drains off, and the "rudemark" dries. Everybody who has travelled in Iceland during spring knows what an enormous difference there is between the clayey gravel-flats in which the horses sink deep down while the ice of the subsoil still hinders the draining off of the water, and the same flats in summer when they are dry, so that horses can gallop across them. During summer the clay-polygons become somewhat depressed. Many of them are however slightly arched during the summer also and retain for a long time a considerable amount of wet in their interior. Clay which easily absorbs water and expands is well known to Swedish geologists¹ who call it "jäslera," and recently it has been connected with "rudemarks."² In the neighbourhood of Reykjavík (Melar) some well-defined "rudemarks" have developed in clay soil where a water-containing layer at a depth of about 1½ metres rests on a thick "móhella" through which water can penetrate only with difficulty, and which therefore freezes in winter into a plate of sub-surface ice. Where the ground consists of clayless sand no "rudemarks" are developed, nor where the subsoil is so porous that water cannot accumulate and form sub-surface ice proper.

In my opinion the knolls which are of such common occurrence in the home-fields of the farmsteads (see Fig. 17) are developed in a similar manner. These knolls are usually larger or smaller elevations of earth which occur together in numbers: the surface-layer consists of humus and plant-remains, but the interior is formed

¹ A. G. Högbom: Om s. k. jäslera och om villkoren för dets bildning (Geol. Fören. Förhandl., Stockholm, XXVII, 1905, pp. 19—36).

² E. Bergström: En märklig form af rutmark från barrskogsregionen i Lappland. Geol. Fören. Förh., XXXIV, 1912, pp. 339—340.

of the clay soil, which projects into them like a kernel and forms the main part of their volume. The knolls have usually a diameter of $\frac{1}{2}$ —2 metres and a height of $\frac{1}{4}$ — $\frac{1}{2}$ metre; sometimes they are somewhat smaller; or they may be larger. The form varies, but is usually oblong. When the knolls are large the channels (*kargatthyfi*) between are but narrow. The thicker soil-layer together with the greensward-covering and the vegetation, are intersected by a network of cracks similar to that in the “rudemarks.” These cracks divide the ground into numerous pieces of various shapes which behave, as regards the sub-surface ice and the moisture, as the “rudemark.” The knolls are dependent on the crack-systems of the substratum. In the knolls the ascending stream of clay and humus particles must be stronger than in the cakes of the rudemark as the greensward, rich in humus, has a very great capillary attraction and an enormous water-capacity — it can absorb water to the extent of 50—60 % of its volume; therefore during the evaporation from the surface it absorbs water vigorously, not only from the thawing ground below, but also laterally from the channels between the knolls filled with water during the spring thaw: in spring the greensward upon the smaller knolls is as saturated with water as a sponge. Bands of volcanic ashes, which were present in the ground or in the greensward before knoll-formation began, become bent upwards in curves according to the form of the knolls — a fact which, among others, is a proof of the local pressure from below in each knoll. In spring, during the melting of the snow, the channels between the knolls are often half filled with water which cannot escape, while the tops of the knolls are dry, sometimes even very dry owing to evaporation, so that the vegetation upon them is totally different from that upon the sides of the knoll. Sometimes large knolls have a kernel of ice far into the summer. The formation of knolls does great damage in the peasants’ home-fields and great trouble is taken in levelling them, but they may reappear comparatively quickly if the ground is not thoroughly drained, so that the surface-water and the water from the melting ice of the subsoil are immediately carried away. In this connection it should be mentioned that where a snow-covering during spring protects the ground for a long time against the action of frost and thaw, no knolls are formed.

Knolls of the kind described above occur in thousands also in uncultivated grasslands with clayey *móhella*-soil, on heather moors and on grass “*móar*”, and here, also exclusively upon somewhat flat

land¹ and in places where the water, for some reason or other, cannot drain off. Here the soil is usually much thinner than in the home-fields but nevertheless it has a very great power of absorption during the process of surface-evaporation; the greater part of these knolls consists of móhella-clay. On an entirely bare clay-flat no knolls are found, and the separate cakes in the „rudemark” rise but slightly in the middle during spring, but not until they are plant-covered and clad with greensward do they bulge and retain their convexity. On a closer investigation it is probable that several transitional forms will be found between “rudemarks” and knolly flats, but investigators have not as yet made this matter a subject for study. Where similar plant-formations (heather and “móar”) occur upon slopes or mountain sides upon which the water easily finds outlets, knolly flats are absent, and “rudemarks” are never found in such localities. Upon mountain-sides small eminences of various kinds may sometimes be observed which are due to underlying stones or ridged mud-flows, etc., but never “thufur” proper. Nowhere have I seen any indications of “rudemarks” or “thufurmarks” being at all connected with mud-flow phenomena.

On the plateau peculiar knolls of usually large size are found which the inhabitants of the different districts call “rústir,” “haugar” or “dys.” These knolls are, as a rule, of irregular, oblong form, and are bare of vegetation on the top, where they consist only of humus and clay. It can be seen that the ground has bulged and the knolls are cracked at the top. In some places there are evident proofs of this being the case: bands of the original soil are seen to lie upon the top of the knoll while the clay and gravel within have poured out of the cracks between the bands. In the neighbourhood of Ulfsvatn on Tvidægra, at a height of 460 metres above sea level, I investigated such knolls in 1898; they were 1—1½ metres in height, 15—20 metres in length and 8—10 metres in breadth. The sides were covered with heather, but Cyperaceæ grew in the intervenning spaces. Similar knolls occur in several other places in the interior of Iceland, but only in one more place did I observe

¹ Dr. H. Jónsson describes a heather-covered “rudemark” where the cracks between the cakes were covered with *Grimmia hypnoides*, but the cakes themselves with *Calluna* and *Empetrum*. This peculiar vegetation — the brownish heather-vegetation divided into numerous polygons by the greyish moss-bands — occurred only upon level ground (Botanisk Tidsskrift, XXVII, 1905, pp. 43 and 44).

them to be as large as those at Ulfsvatn, viz. in East Iceland on the plateau south-east of Snæfell, at a height of 690 metres above sea-level. This was in 1894, but the inclemency of the weather prevented me from making a halt at the place. Here, also, several of the knolls had burst and discharged a large quantity of clay-soil. This form of knoll occurs especially at the edge of the bogs where the foot of the knoll stands in water during the melting of the snow: where the supply of water is too abundant these knolls do not occur. It is a fact peculiar to all knolls, both in the lowlands and on the plateau, that they consist of móhella-soil and humus intermixed with clay; this is true also of the "rudemarks" with the exception that more gravel and stones are found in them than in the plant-covered ground. As mentioned above, there is no direct connection between the mud-flow phenomena and the "rudemarks" and knolls, but it may happen that a flat with either of these surface-forms is afterwards affected by mud-flows; this is then a secondary phenomenon. Where subsoil-ice is absent, as for instance in the neighbourhood of the hot springs which are scattered in hundreds all over the country, I do not remember to have seen "rudemarks" or "thufur" proper. Upon the plateau itself "rudemarks" are rather rare, but, on the other hand, various mud-flow phenomena are common; thus, stones are often seen arranged in bands on the slopes, and in various other ways which, however, I regret to say, have not as yet been more closely investigated. On basaltic plateaus covered with coarse basalt-gravel and blocks of rock, patches of clay are now and then seen which appear, in the middle, to have thrust up from below and spread out slightly on all sides.

Besides these knolls there are many other similar eminences in the gravel-covered ground which are called knolls, but are due to quite different causes and have a different origin. Sometimes nodules on the greensward are due to the form of the substratum, as where a thin layer of soil occurs upon lava, or upon a stony and rugged bottom. In blown sand, knolls are formed around roots of *Elymus arenarius*, *Halianthus peploides* and other plants. Where the ground-water stands very high, as in many extensive boggy tracts, so that the entire surface freezes into an ice-cake, only small knolls of organic material are seen, formed of moss and Carices. On hard grassland, on gravelly flats and similar places, small

knolls are formed of the rootlets, leaf-rosettes, etc. of various plants. Sometimes knolls are formed of organic material in places where a small spot is constantly manured, e. g. the so-called "bird-knolls" on higher levels, where bird of prey are in the habit of alighting, and the characteristic Icelandic "dog-knolls" (hundapúfur) along the roads where the dogs are wont to stop, which almost all travellers in Iceland have for companions.

III. CLIMATE.¹

ALONG the coast of Iceland, generally speaking, a decidedly insular climate prevails, the conditions of which are determined by the wind-distribution over the North Atlantic and by oceanic currents. The climate has an oceanic character, the summer being cool and the winter usually mild — but it may become very cold when northern winds prevail and the Polar ice blockades the coasts. The air is usually damp, and storms are very frequent and violent. The climate varies, however, rather considerably in the different parts of the coast, and there is also a considerable difference between that of the coast and the interior.

¹ Meteorological observations from Iceland are published annually in "Meteorologisk Aarbog," 2. Del. Bilandene. København (Annuaire Météorologique. Publié par l'Institut météorologique Danois. Deuxième partie. Les colonies), in Danish and French. See also, *Eléments météorologiques des îles Féroé, de l'Islande et du Groenland*. Copenhagen, 1899. The climatological observations from Iceland have, as yet, been worked out to a small extent only, and there exist no larger and more exhaustive accounts of the climate of Iceland: only some small, but valuable, papers are to hand by V. Willaume-Jantzen (*Climat du littoral islandais*. Congrès maritime international de Copenhagen, 1902; and some articles in "Salomonsens Leksikon," 1899, and in "Atlanten," 1904); use has been made of these in this paper. The climatological means which are given in this paper have been calculated and classified at the Meteorological Institute in Copenhagen in 1910, and were previously published, 1911, only in my book on Iceland "Lýsing Islands," in which there is a section (vol. II, pp. 327—394) giving an account of our present knowledge of the climate of Iceland and its weather-conditions during historic times. Among older papers on the climatology of Iceland may be mentioned J. Thorstensen, *Observationes Meteorologicæ, 1823—1837*, in *Islandia factæ*. Hafniæ, 1839; J. F. Schouw, *Nogle Bemærkninger om Vejrtiliget paa Island i Vinteren 1824—25* (Tidskrift for Naturvidenskaberne. København, 1826, IV, pp. 259—262); Mag. Pedersen, *Undersøgelse om Barometrets daglige Middelocillation paa Island* (Overs. Vid. Selsk. Forh., 1845, pp. 65—69); and lastly observations by H. J. Scheel from Akureyri, 1811—13 (*Annals of Philosophy*. Edited by Th. Thomson, Series I, Vol. XI, London, 1818, pp. 96—103 and 169—175), and observations by A. O. Thorlacius from Stykkisholm, published in "Journal of the Scottish Meteorological Society," 1869, 1873, etc. Articles on the winds, drift-ice and other more special subjects will be mentioned subsequently in footnotes to the text.

The climate of Iceland, owing to oceanic currents, is much milder than could be expected from the position of the island. As is well-known the temperature of the air varies greatly at the same latitude on the eastern and western sides of the North Atlantic. Stykkisholm in Iceland lies about 65° N. lat. as also Brönö in Norway and Angmagsalik on the east coast of Greenland, but the temperature varies greatly in these three places as shown in the following table:—¹

	February	July	Average for year
Brönö	— 1.4° C.	12.8° C.	5.2° C.
Stykkisholm	— 2.7° C.	9.7° C.	2.8° C.
Angmagsalik	— 10.8° C.	5.4° C.	— 2.6° C.

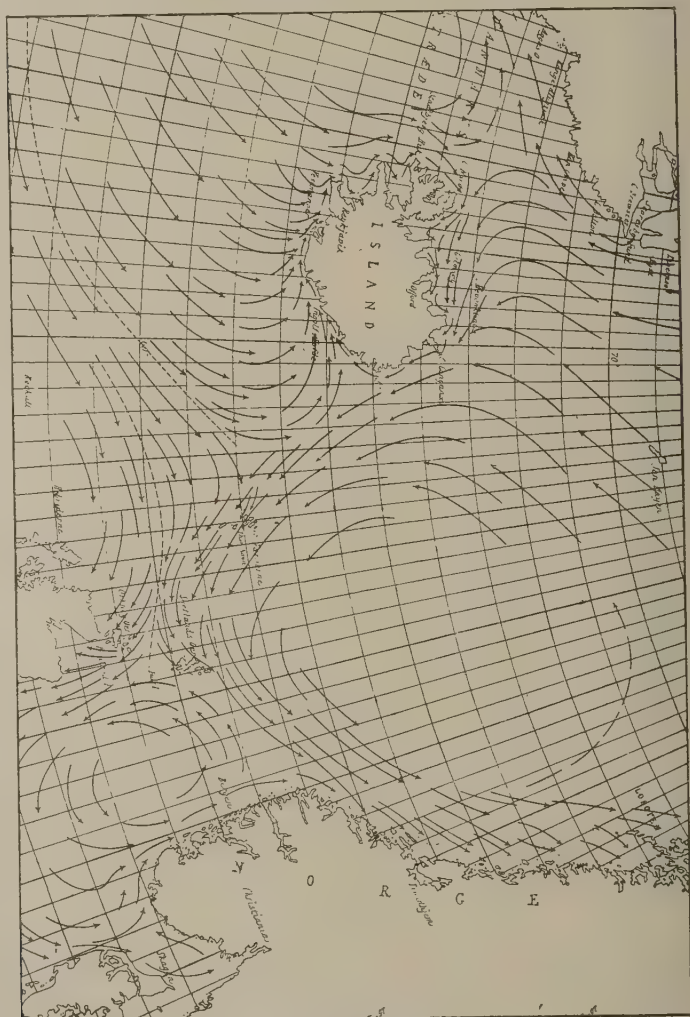
The above table shows, among other things, the great influence exerted by the cold, ice-carrying current in Denmark Strait. On the whole, oceanic currents have a great effect upon the climate of Iceland. The west coast has its temperature raised by the Gulf Stream. One branch of this passes Cape Nord and continues its course along the north coast where it becomes cooled, but has still a comparatively high temperature which is distinctly felt at Grímsey. Another branch of the Gulf Stream comes from the south up towards the south and east coasts where it meets the cold Polar current which comes down along the east coast of Greenland and at Iceland divides into two branches. Of these branches the one broad branch turns down through Denmark Strait, while the other flows down towards Langanes, and thence southwards along the east coast of Iceland to South Iceland where it passes between the coast and the warm current outside. The conditions connected with these currents exert a great influence upon the temperature of the ocean off different parts of the coast and thus upon the flora and fauna of the ocean, which differ greatly according to whether they are under the influence of cold or warm water. Thus, the algal vegetation along the north-eastern coast of Iceland has a different character — is more Polar — than towards the south-west; this applies also to the fish fauna, and the deep-water, spot-bound fauna, as well as to the plankton.

The temperature of the surface-water of the ocean varies therefore in no slight degree off the different parts of the coast. During winter the temperature of the ocean-water off the east coast, where the influence of the Polar current is greatest, is on an average 0.8°

¹ Julius Hann: Handbuch der Klimatologie. Stuttgart, 1908, I, p. 181.

(Papey); off the north coast 2° (Grímsey); off the west coast 1° (Stykkisholm); and off the south coast 4.1° (the Vestmannaeyjar); but it varies rather considerably with the increased or decreased

Fig. 19. Reduced photographic reproduction of Ryder's chart of the North Atlantic Ocean.



proximity of the Polar ice. The mean summer temperature of the ocean round Iceland is 5.8° at Papey, 6.1° at Grímsey, 9.7° at Stykkisholm, and 10.4° at the Vestmannaeyjar. For further particulars consult the following table: —

Table I. Mean Temperature of the Surface Water of the Ocean round Iceland for the Period 1872—1906. (Centigrade scale used.)

Name of Station	January	February	March	April	May	June	July	August	September	October	November	December	Winter	Spring	Summer	Autumn	Average for year
Stykkisholm..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.9	0.3	0.4	1.7	4.7	8.2	10.4	10.6	9.1	6.3	3.7	1.8	1.0	2.3	9.7	6.4	4.9
The Vest-mannaeyjar	4.1	4.1	4.5	6.1	7.7	9.5	10.9	10.8	9.1	6.8	5.1	4.1	4.1	6.1	10.4	7.0	6.9
Papey....	0.7	0.4	0.5	1.5	3.1	4.8	6.0	6.6	6.2	4.3	2.6	1.3	0.8	1.7	5.8	4.4	3.2
Grímsey.....	1.8	1.4	0.7	1.3	2.6	4.2	6.6	7.4	6.9	5.3	4.1	2.9	2.0	1.5	6.1	5.4	3.8

The temperature-conditions of the coastal districts correspond very closely with those of the ocean. The north-east coast has, on an average, a mean winter-temperature of from -2° to -4° C., a summer temperature of 6° to $7\frac{1}{2}^{\circ}$ C., and a mean for the whole year of 1° to 2° C.; while the south-west coast has a winter temperature of 0° to -2° C., a summer temperature of 9° to 10° C., and one for the whole year of 3° to 4° . When the Greenland drift-ice blockades the coast, the difference between these temperatures is considerably greater. In the severe ice-year, 1881, the difference between the temperature on the isle of Grímsey and in the Vest-mannaeyjar, from January to March, was $10\frac{1}{2}^{\circ}$ to 14° C., while normally in these months it is only $3\frac{1}{2}^{\circ}$ to $5\frac{1}{2}^{\circ}$; in the same months (in 1881) the difference of temperature between Stykkisholm and the Vestmannaeyjar was 7° to 10° C., while normally it is only 3° to 4° . Therefore the temperature varies very greatly from year to year, and so also does the mean of the different months. For instance, take the month of March: at Stykkisholm the highest mean temperature in a period of 33 years was 2.9° C.; and the lowest mean in the same period was -13.3° C. From this it will be seen that the Polar current, and especially the drift-ice, exercises a great influence upon the climate in Iceland and thereby upon the vegetation and the means of sustenance of the people. When the Polar ice arrives at the north coast the temperature immediately falls: when in May and June the people who live in South Iceland see that it is snowing on the mountains, they at once take it as a sign that the dreaded drift-ice is about to blockade the coast of

North Iceland. So long as the ice drifts backwards and forwards along the coast, the weather continues to be very changeable and stormy; but once the ice has been grounded on the land, the weather becomes more settled, although colder. The parts of the coast which are most subject to be blockaded by the drift-ice are the north and east sides of the north-western peninsula, especially Strandasysla, and Langanes and Melrakkasljetta. In these districts the effect of the presence of the drift-ice is shown both in the wider extension of the snow-wreaths and in the character of the vegetation. On the east coast of the north-western peninsula, south of Cape Nord (also called Cape Horn) there is no vestige of coppice-wood, while this occurs luxuriantly on the western and south-western side of the peninsula, and at the heads of the fjords. Cabbage and potato plots are also absent along this coast, north of $65^{\circ} 40'$ N. lat.; while small plots of cabbages occur frequently in Aðalvík on the north-western coast of the peninsula at $66^{\circ} 25'$ N. lat. Even at the head of Hunaflói the influence of the drift-ice is evident: *Chamaenerium latifolium* which flowers every year on the plateau, 600—700 metres above sea-level, flowered only twice during eleven years (1878—88) at Midfjörður. In the districts which are most exposed to the effects of the Polar ice, the herbage is extremely poor owing to the constant coldness of the springs and the rawness of the summers; the frequent snow-falls even at midsummer, make hay-making precarious, so that the sheep and cattle — and thereby the inhabitants — are liable to suffer want.

During the nineteenth century the coast of Iceland has been free from ice on an average about one year in every four or five; but no rule can be formulated for the arrival of the Polar ice on the coast of Iceland; sometimes it remains absent for many years: sometimes it visits the coast several years in succession. The ice arrives at different times — as a rule from January to April; if it arrives early, it usually drifts away soon without doing any great damage, but if it arrives near the time of spring, it often remains till far into summer, and causes much inconvenience, hindering navigation and fishing, spoiling the hay-harvest, etc. But it almost invariably drifts away at the end of August, and for the last four months of the year the coast is almost always free from ice. As a rule, the Polar current first carries the drift-ice to the north-western peninsula of Iceland, off Cape Nord, and the main mass is carried out through Denmark Strait; but that part of the ice which besets

Hornstrandir (the coast down either side of Cape Nord), is carried by the coastal current (the Irminger Current) along Strandasysla into Hunaflói, from thence outwards along the east coast of this fjord, then further eastwards along the entire north coast, past Langanes and on, down to the east and south coasts, where it either melts or else drifts away into the open sea. The ice which comes to South Iceland always comes from the east, never from the north-west. In severe ice-years the drift-ice may blockade the whole of the south coast as far as to Cape Reykjanes; on the other hand, it very rarely happens that any drift-ice enters Faxaflói and more rarely still that any icebergs drift past the north-western fjords into Breiðfjörður; the ice is not known to have been grounded on the land, down past Patriksfjörður, for the last 200 years. The most severe ice-year known was the year 1695; in that year drift-ice surrounded the whole island with the exception of Snæfellsnes — a fact unparalleled in the history of the country. In most of the places the ice occurred in such quantities in that year that open water was not visible from the highest mountains. As usual the ice drifted from North Iceland to South Iceland and then southwards and reached Thorlakshöfn as early as April; from thence it drifted into Faxaflói as far as Hítárós, and from the north-west the ice drifted past Látrabjarg into Breiðfjörður. In the beginning of May it was possible to walk and ride everywhere outside all the fjords of North Iceland. It sometimes happens that the drift-ice drifts to Langanes and then down to the east coast without touching the north coast.¹ The Polar current bears great quantities of drift-wood to the northern coast of Iceland, most frequently to the neighbourhood of Cape Nord and Langanes. The greater part of this drift-wood starts probably from Siberia; that of most common occurrence is *Larix sibirica*, *Picea obovata*, *Abies sibirica*, *Pinus cembra*, *Pinus silvestris*, *Populus tremula*, *Salix vitellina*, and others.²

¹ Th. Thoroddsen: Den grönländska drifisen vid Island (Ymer. Stockholm, 1884, pp. 145—160). C. Ryder: Isforholdene i Nordhavet, 1877—1892 (Tidsskrift for Søvesen, 1896). V. Garde: Isforholdene i de arktiske Have in Nautisk Meteorologisk Aarbog of 1898 and subsequent years (in Danish and English). W. Meinardus: Periodische Schwankungen der Eisdrift bei Island (Annalen der Hydrographie und Maritimen Meteorologie, 1906).

² J. G. Agardh: Om den Spetsbergiska Drifvedens ursprung (Övers. af Kgl. Vet. Ak. Förh., 1869, No. 2, pp. 97—119). A. G. Nathorst: Två somrar i norra Ishafvet. Stockholm, 1900, I, p. 345. Th. Thoroddsen: Ferðasaga af Vestfjörðum (Andvari, XIII, 1887, pp. 164—168) and Ferðabók, II, 1914, pp. 63—70. Compare Geografisk Tidsskrift, IX, p. 45. E. Olafsson: Rejse gennem Island (1772), I, pp. 508—513. O. Olavius: Oekonomisk Rejse gennem Island (1780), pp. 126—146.

The drift-ice also carries to the coast of Iceland fragments of rock which are not found in Iceland (gneiss, granite, talc-slate, mica-slate, etc.), and also gravel, clay and earth from other Arctic countries. Moreover, the warm water of the Gulf Stream sometimes carries drift-material with it from southern parts, e. g. mahogany, sugarcane, "nuts" of *Entada Gigalobium*, *Mucuna urens*, *Guilandina Bonducella*, etc.

The weather of the North Atlantic Ocean depends upon the winds, which also exercise a great influence upon the currents around Iceland. The mean atmospheric pressure in the North At-

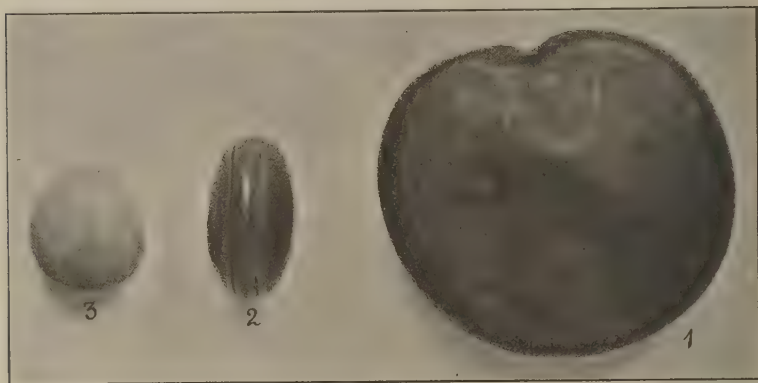


Fig. 20. Seeds of *Entada Gigalobium* (1), *Mucuna urens* (2), and *Guilandina Bonducella* (3).

lantic is generally lowest to the south-west of Iceland but there is, in addition, another centre of low barometric pressure north-east of Iceland; on the whole, the direction of the winds over Iceland is determined by this. In West and North Iceland the majority of the winds blow from SE., E. and NE., while on the east coast winds from the NE. and NW. are nearly equally numerous (20 % and 17 % relatively) because here both the above-mentioned centres of low atmospheric pressure try to prevail. This is true of the average condition only, because in reality the wind-conditions from day to day are very variable, as the ocean here is constantly visited by moving centres of depression. The barometer in Iceland is subject to very great changes. In Reykjavík the barometer, during a period of 28 years, has oscillated between 789 mm. and 697 mm.; at Stykkisholm, during one of 33 years, between 789 mm. and 700.3 mm.; in the Vestmannaeyjar during a period of 29 years, from 789 mm. to

Table II. Atmospheric Pressure along the coast of Iceland for the Period 1872—1906:
700 mm. +, reduced to 0° C., and to sea-level.

Name of station	January	February	March	April	May	June	July	August	September	October	November	December	Winter	Spring	Summer	Autumn	Average for the year
Stykkishólmur.																	
From $\frac{1}{6}$ 1873 to $\frac{31}{12}$ 1906.																	
Mean Atmospheric Pressure....	49.0	51.6	54.4	57.2	60.7	58.9	57.4	57.4	54.5	54.7	52.5	48.9	49.8	57.4	57.9	53.9	54.8
Mean of maximum pressure....	66.8	65.5	66.4	63.6	65.7	65.2	62.5	63.9	62.9	67.6	64.7	65.2					57.9
Mean of minimum pressure....	36.8	36.4	40.5	47.6	51.3	52.4	51.4	50.5	47.5	45.7	42.5	40.8					52.0
Absolute maximum pressure....	85.2	89.1	88.5	79.4	83.5	78.8	74.0	73.6	75.0	82.7	80.3	83.6					89.1
Absolute minimum pressure....	5.7	0.3	12.3	18.0	30.3	25.2	30.7	24.0	14.8	20.6	13.2	3.7					0.3
Vestmannaeyjar.																	
From $\frac{1}{7}$ 1877 to $\frac{31}{12}$ 1906.																	
Mean Atmospheric Pressure....	49.3	51.9	53.1	56.3	60.4	59.4	57.3	56.7	54.4	54.5	50.9	48.1	49.8	56.6	57.8	53.3	54.4
Mean of maximum pressure....	63.9	65.8	66.8	61.9	64.0	64.9	61.6	64.1	64.7	61.6	61.8	55.3					57.2
Mean of minimum pressure....	36.1	37.3	37.9	47.5	52.4	54.5	52.4	50.1	49.0	45.2	41.2	41.4					51.9
Absolute maximum pressure....	88.5	87.5	89.0	80.2	83.0	77.9	71.9	75.3	74.8	80.2	81.4	79.2					89.0
Absolute minimum pressure....	6.4	699.2	15.7	18.0	30.3	23.6	33.7	32.3	18.1	15.5	5.6	5.5					699.2
Þerfjörður.																	
From $\frac{1}{13}$ 1872 to $\frac{31}{12}$ 1906.																	
Mean Atmospheric Pressure....	50.4	53.3	54.9	58.2	61.1	59.5	57.7	57.4	55.5	55.2	53.4	50.5	51.4	58.1	58.2	54.7	55.6
Mean of maximum pressure....	65.9	67.2	65.8	64.1	65.4	65.9	62.2	63.8	64.6	66.1	63.8	63.9					58.1
Mean of minimum pressure....	37.1	39.4	40.8	47.5	52.4	53.9	51.3	50.5	48.6	46.2	44.0	44.1					53.1
Absolute maximum pressure....	87.8	88.7	87.7	80.5	83.2	77.7	72.9	73.8	76.7	79.9	80.0	81.4					88.7
Absolute minimum pressure....	7.8	4.9	16.0	18.0	28.1	31.3	35.9	34.5	21.3	21.0	13.7	6.2					4.9
Akureyri.																	
From $\frac{1}{7}$ 1873 to $\frac{31}{12}$ 1906.																	
Mean Atmospheric Pressure....	50.7	53.3	55.6	58.5	61.5	59.4	57.8	57.9	55.5	55.9	53.9	50.6	51.5	58.5	58.4	55.1	55.9
Mean of maximum pressure....	68.4	67.0	66.7	65.3	66.8	66.1	62.5	64.6	63.7	68.1	64.7	65.9					58.4
Mean of minimum pressure....	38.1	38.7	43.3	49.2	52.1	53.2	51.6	51.0	48.0	47.3	45.0	43.3					52.5
Absolute maximum pressure....	85.6	89.0	88.2	83.8	83.9	77.6	73.2	74.3	77.2	83.5	81.2	81.5					89.0
Absolute minimum pressure....	8.8	5.7	15.2	19.6	30.1	26.0	34.8	28.6	18.4	17.1	15.3	8.1					5.7

Table III. Prevailing Winds expressed as percentages.

Name of station	January	February	March	April	May	June	July	August	September	October	November	December	Average for the year
Vestmannaeyjar													
($1/7$ 1877 to $81/12$ 1906).													
N.....	13	13	18	13	10	4	7	10	11	18	17	17	12
NE.....	3	4	3	3	2	2	1	2	1	4	4	3	3
E.....	19	22	24	27	27	24	20	23	26	21	20	18	22
SE.....	9	8	8	10	10	14	13	9	10	9	8	8	10
S.....	10	10	9	9	8	9	5	5	9	8	9	10	8
SW.....	16	13	9	7	8	10	9	9	11	8	12	14	11
W.....	8	9	7	7	8	9	13	8	6	6	6	7	8
NW.....	3	3	4	5	4	4	7	4	4	4	4	3	4
Calm.....	19	18	18	19	23	24	25	30	22	22	20	20	22
Papey													
($1/8$ 1873 to $81/12$ 1906).													
N.....	11	15	13	12	10	5	5	8	7	12	14	11	10
NE.....	11	13	18	26	27	24	26	24	19	16	15	12	20
E.....	4	7	6	8	9	13	10	10	8	8	6	6	8
SE.....	5	5	5	6	5	6	6	5	6	5	4	5	5
S.....	7	7	6	8	7	10	10	8	8	5	6	7	8
SW.....	19	17	12	12	14	18	13	12	20	14	15	17	15
W.....	9	6	5	3	4	5	5	3	5	5	6	7	5
NW.....	24	20	24	15	13	5	6	10	14	24	25	27	17
Calm.....	10	10	11	10	11	14	19	20	13	11	9	8	12
Stykkishólmur													
($1/8$ 1873 to $81/12$ 1906).													
N.....	5	5	5	6	6	5	5	9	6	8	6	7	6
NE.....	14	17	18	17	16	10	10	12	15	19	20	14	15
E.....	21	23	24	25	21	18	21	21	19	22	21	24	22
SE.....	16	15	15	15	14	14	10	10	15	17	16	14	14
S.....	13	11	9	10	11	13	9	9	13	11	9	10	11
SW.....	16	15	12	6	6	8	6	5	10	9	12	16	10
W.....	5	4	5	6	8	12	15	11	7	4	5	4	7
NW.....	1	1	1	1	4	7	8	6	2	1	1	1	3
Calm.....	9	9	11	14	14	13	16	17	13	9	10	10	12
Grímsey													
($1/7$ 1873 to $81/12$ 1906).													
N.....	8	8	9	7	8	5	8	7	6	6	8	9	7
NE.....	16	18	18	19	20	12	13	12	13	19	21	16	17
E.....	15	19	20	26	27	27	28	27	23	21	20	16	22
SE.....	20	21	20	16	10	11	9	12	17	18	15	20	16
S.....	7	7	5	4	2	3	2	2	5	6	6	8	5
SW.....	9	6	5	3	2	3	2	2	5	6	7	8	5
W.....	14	12	12	10	9	10	10	10	13	11	13	12	11
NW.....	5	5	5	5	9	10	11	12	8	6	6	6	7
Calm.....	6	4	6	10	13	19	17	16	10	7	4	5	10

699.2 mm.; at Berufjord during a period of 34 years, from 788.7 mm. to 704.9 mm.; and at Akureyri, during one of 33 years, from 789 mm. to 705.7 mm. The paths of the moving centres of depression lie especially frequently south of Iceland so that one centre of depression after the other crosses the Atlantic from the west with a main direction of east or north-east; sometimes nearer, sometimes further from Iceland. This movement of low pressure centres causes the wind to veer towards the sun, especially from S. or SE. through E. and NE. Table III shows that at Stykkisholm, very frequently the winds blow from S. and SW. (such form 11 % and 10 % respectively) which is due to the fact that Denmark Strait also provides a path for the moving centres of depression; they come from the south and cause on Iceland a veering of the wind with the sun from SE. or S. through SW. It is probably these centres of depression which cause the rather frequent winds from the W. and SW. at Grimsey and Papey respectively. There may, however, occur longer periods in which the winds of Iceland are rather constant, the lowest atmospheric pressure over the North Atlantic remaining at the same place. The wind-conditions are generally favourable for Iceland, the warm air from the Atlantic Ocean is carried in over the land, while it is rare for cold winds to be thus brought during winter. According to observations taken at Stykkisholm on the west coast, the warmest winds there are the SE., S. and SW. while the greatest cold is caused by the N., NE. and E. winds. The difference between the temperature induced by the warmest and by the coldest winds is on an average 9° — 10° C. in the months of December to April, and 4° — 6° C. in the other months. The temperature may show great differences according to whether northerly or southerly and easterly winds are the prevalent ones for any length of time; thus, the mean temperature at Stykkisholm in March 1856 was $+4.3^{\circ}$ when southerly winds prevailed, and in March, in the ice-year 1881, the mean temperature was -13.3° when easterly winds were prevalent.¹ Conditions pertaining to the atmospheric pressure over the Atlantic, which is specially

¹ V. Willaume-Jantzen: *Climat du littoral islandais*, 1902. N. Hoffmeyer: *Die Vertheilung des Luftdruckes über den nord-atlantischen Ocean während des Winters und deren Einfluss auf das Klima von Europa* (*Zeitschrift für Meteorologie*, Wien, 1878. Bd. XIII. Nr. 22). N. Hoffmeyer: *Etude sur les tempêtes de l'Atlantique septentrional*. Copenhagen, 1880. G. Rung: *Répartition de la pression atmosphérique sur l'océan atlantique septentrional*. Copenhagen, 1894. V. Garde: *Vindkort over den nordligste Del af Atlanterhavet*. *Nautisk-meteorologisk Aarhog for 1899*. København, 1900. S. 25—46).

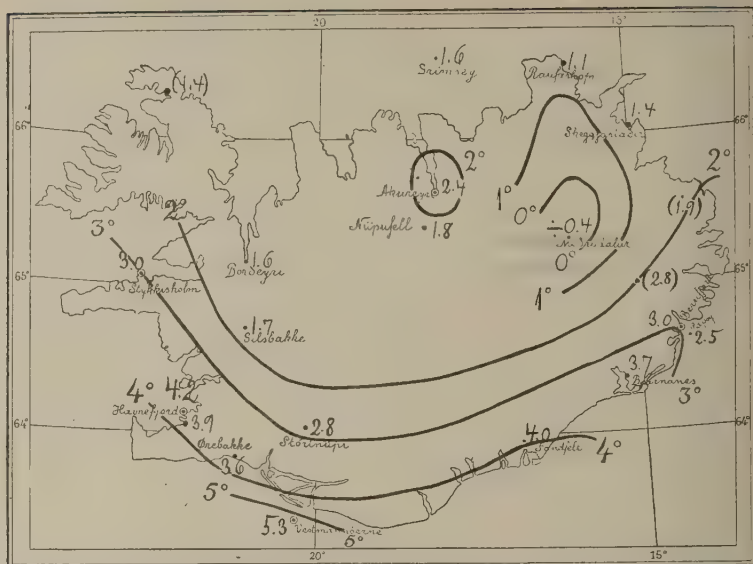


Fig. 21. The mean annual temperatures of 28 years (1874—1901). (V. Willaume-Jantzen.)

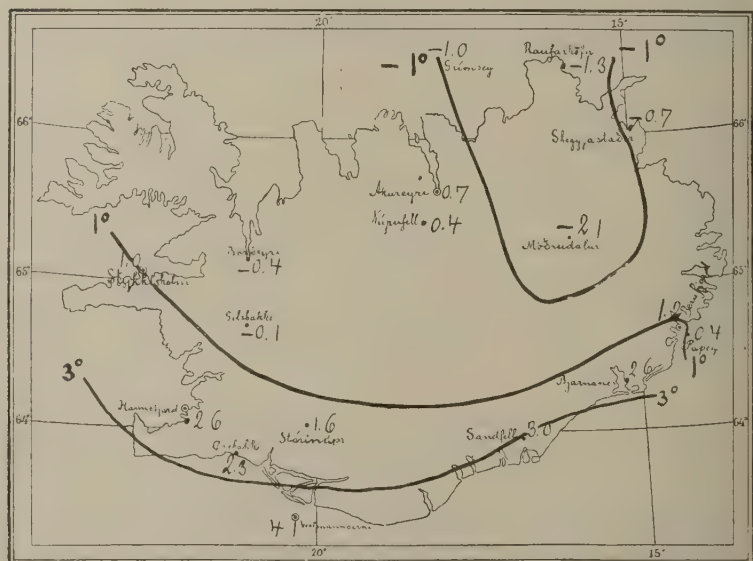


Fig. 22. The meanspring temperatures for the period 1874—1901. (V. Willaume-Jantzen.)

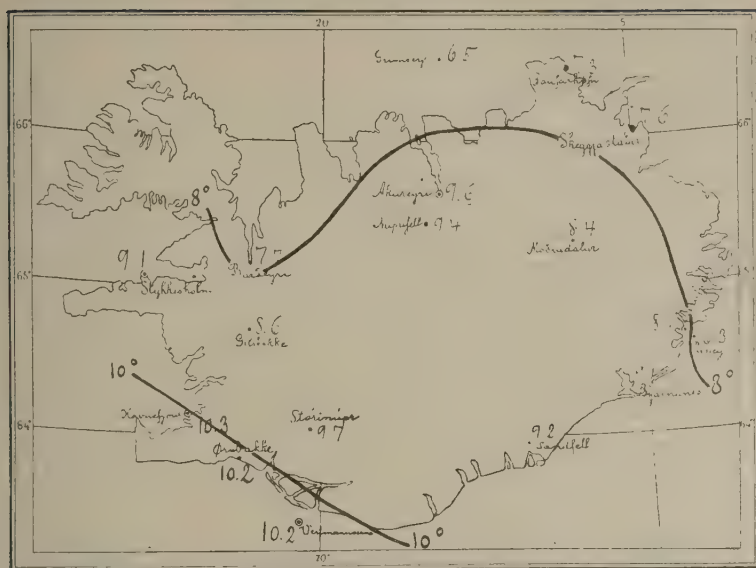


Fig. 23. The mean summer temperatures for the period 1874—1901. (V. Willaume-Jantzen.)

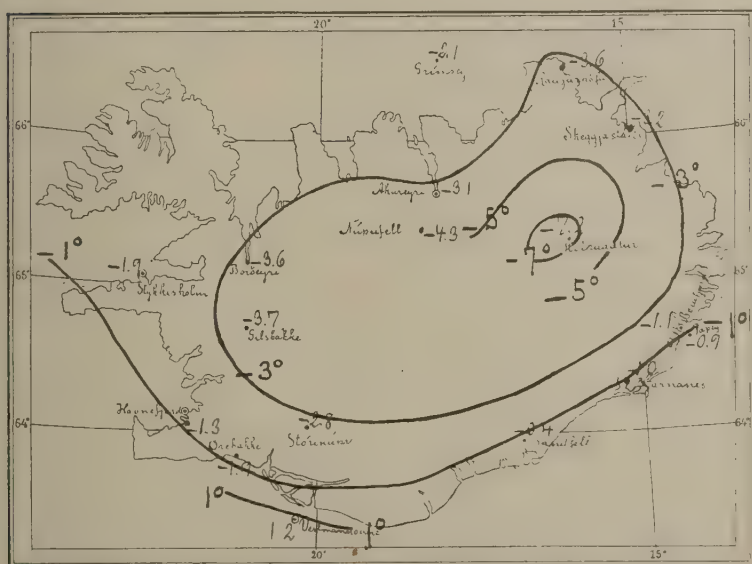


Fig. 24. The mean winter temperatures for the period 1874—1901. (V. Willaume-Jantzen.)

expressed in the height of the barometer at Iceland and in the Azores, have, as is well-known, a very great influence upon the climate of western Europe.¹

The wind blows with great force over Iceland and storms are frequent, especially in the winter half of the year. At Stykkisholm there are, on an average, 50 days of storm annually; in the Vestmannaeyjar 25; and on Grímsey 11. On the west coast the majority (60 %) of the storms are from the NE., while in East Iceland the NW. wind is the most stormy, causing 50 %. As the fisheries along the coast of Iceland are carried on especially in the winter half of the year (the fishing season along the south-west coast begins in February), the storms constantly cause a great many disasters at sea. During the years 1850—1877 (with the exception of 1853 and 1875, for which no data are to hand) 2008 people were drowned off Iceland, forming 3 % of the total number of deaths during those years; of these, 60 % were drowned in March. During the years 1881—1910, 2096 persons were drowned out of a population of 70,000—80,000. Both in northern and eastern Iceland the Föhn wind, which blows down from the Jökulls of the plateau, is fairly common during winter and causes a sudden rise of temperature, resulting in the melting of the snow in the lowlands and of the ice upon the surface of the lakes and rivers. N. Hoffmeyer² describes a Föhn wind which blew down from Vatnajökull over south-east Iceland from September 18th to 26th, 1877, causing the temperature at Berufjord and on Papey to rise from 7°—8° C. to as much as 18°—20° C.; otherwise, such a high temperature is very rare at these stations, even at midsummer.

The oceanic character of the Icelandic climate is manifested in the low degree of heat experienced during summer and the mildness of the winter. The mean temperature of the coldest days along the coast of Iceland (Stykkisholm, Berufjord and Grímsey) was in

¹ J. Hann: Die Anomalien der Witterung auf Island in dem Zeitraume 1851 bis 1900 und deren Beziehungen zu den gleichzeitigen Witterungsanomalien in Nordwesteuropa (Sitzungsberichte d. Akademie d. Wissenschaften in Wien. Math.-naturw. Klasse. Band 113. Abteilung II a. Wien, 1904. S. 183—269). H. H. Hildebrandsson: Quelques recherches sur les centres d'action de l'atmosphère IV. Sur la compensation entre les types des saisons simultanés en différentes régions de la terre (Kungl. Svenska Vetenskapsakademiens Handlingar. Band 45, No 11. Stockholm, 1910).

² N. Hoffmeyer: Vejrforholdene paa Island i Vinterhalvaaret 1877—78 (Tidskrift for populær Fremstilling af Naturvidenskabene, 5. Række, V Bind. 1878, pp. 161—172).

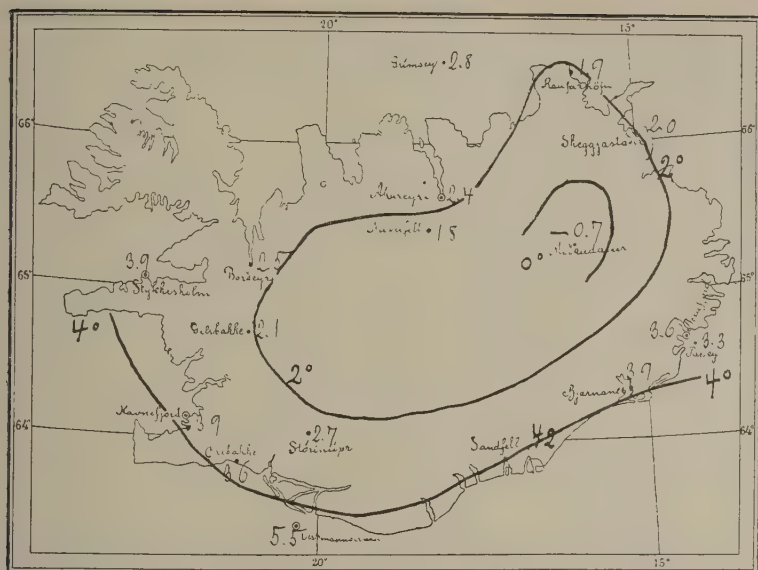


Fig. 25. The mean autumn temperatures for the period 1874—1901. (V. Willaume-Jantzen.)

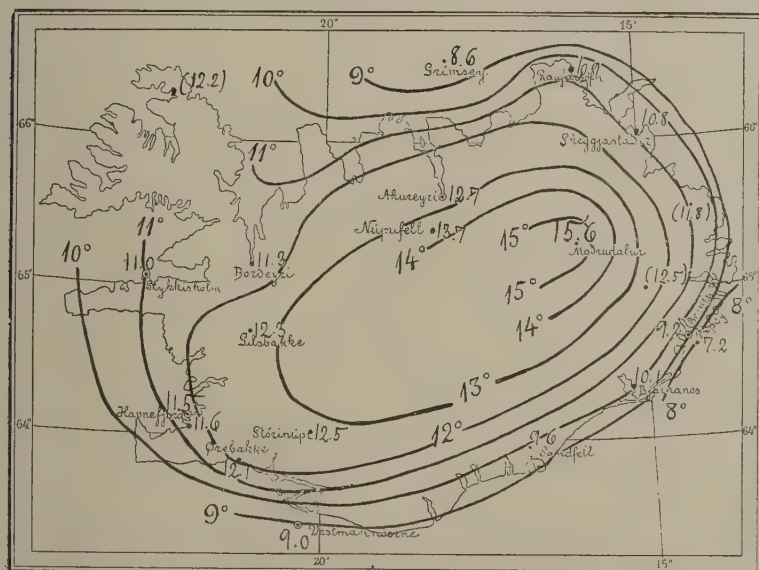


Fig. 26. The differences between the summer and winter temperatures of 28 years (1874—1901). (V. Willaume-Jantzen.)

February and in the first half of March — 2° to -4° C., which is only from 1° to 3° colder than the average temperature of the coldest days in Copenhagen; but, on the other hand, the warmest days in Iceland, which occur in the latter half of July and in August have, on an average, a temperature of only from 7° to 10° C. There are, however, numerous oscillations from year to year, mostly during winter, less frequently during summer. The normal temperature is below zero (Celsius) from the last days in November to the first days in April, or even May 1st on Grímsey. Therefore the Icelandic summer is very unfavourable to plant-life, the temperature being so low during growth-period. The highest mean temperatures for any month fall in July and August and even these reach only to 11° — $12\frac{1}{2}^{\circ}$ C. (Papey 8.5° and 9.6° ; Vestmannaeyjar 12.7° and 12.3°) — the temperature of a mild May or cool September in Copenhagen. By exception, on some days, the heat may be very great; the greatest amount of heat registered at Berufjord was 26.3° C., on Grímsey 26.2° C., at Stykkisholm 22.9° C., and in the Vestmannaeyjar 21.2° C. But in the interior of the island — in the valleys — a higher temperature (27° — 28° C.) has occasionally been registered. The lowest temperature registered at Berufjord was -23.1° , in the Vestmannaeyjar -20.9 ; at Stykkisholm -26° , and on Grímsey -30° .¹ At the coast in Iceland the average temperature of the day and night rarely exceeds 15° C., and at Berufjord there occur, as a rule, during the year, only four days with such a temperature, but in Mödrudalur six to seven; a fact which shows among other things that the summer temperature is often higher in the interior of the country, while the cold there is also greater during the winter. On ascending to the interior districts the climate is found to be no longer so decidedly oceanic as along the coasts, and the vegetation also increases in density the further one proceeds upwards, following the valleys. Coppice-woods often thrive at the head of valleys in places where birch-coppices cannot grow out at the coast. The mean temperature of the coldest day and night in Mödrudalur was -29° C., at Berufjord -19° C. During the period March 6—12, 1892, when the cold was very severe, the mean tempera-

¹ All these figures are those for the cold, drift-ice winter 1880—1881. But it should be mentioned here that the Grímsey station had no maximum thermometer, and that the temperature -30° C. was one which was registered during the day. In reality the cold had probably been greater, because in the same winter I noted early in the morning of some days, at Mödruvellir in Hörgárdal a temperature of -32° to -36° C.

ture in the Vestmannaeyjar was -7° C., at Berufjord $-11\frac{1}{2}^{\circ}$ C., on Grímsey $-15\frac{1}{2}^{\circ}$ C. and in Mödrudalur $-24\frac{1}{2}^{\circ}$ C.

The mean temperature for the whole island, according to the observations to hand, is $2\frac{1}{2}^{\circ}$ C., but the real temperature is undoubtedly considerably lower, because only one station on the immense plateau was included. The mean temperature of the winter on the north and east coasts ranges between -1° and $-3\frac{1}{2}^{\circ}$ C., and of the summer between $6\frac{1}{2}$ and 8° C., of South Iceland the mean temperature for the winter ranges between 0° and -2° C., and the summer temperature between 9 and 10° . The difference between the summer and winter temperatures increases with the distance from the sea, as shown in Fig. 26. The difference is greatest between the plateau and the Vestmannaeyjar. The mean temperature for the year in Mödrudalur is -0.4° C., and in the Vestmannaeyjar 5.3° C.; the mean summer temperature of Mödrudalur 8.4° C. and of Vestmannaeyjar 10.2° C.; and the winter temperature of Mödrudalur -7.2° C., and of Vestmannaeyjar $+1.2^{\circ}$ C.; thus the winter in Mödrudalur is 8° colder than in the Vestmannaeyjar. The south coast is the warmest part of the country, and in the Vestmannaeyjar the mean temperature of none of the months is below freezing point. The mean temperature for the year on the south coast is as follows:—Bjarnanes 3.7° C., Sandfell in Öræfi 4° , Eyrarbakki 3.6° , Havnefjord 3.9° and Reykjavík 4.2° . The climate of the coast of Iceland is said to be mildest below Eyjafjöll and in Mýrdalur, but no observations are to hand from these two places.

Table IV. Account of the Air Temperature along the coasts, in the interior districts, and on the plateau, according to the seasons.

	Number of stations	Winter	Spring	Summer	Autumn	The year
The Vestmannaeyjar	1	1.2	4.1	10.2	5.5	5.3
South-west coast (Stykkisholm-Eyrarbakki)	3	-1.7	2.0	9.9	3.8	3.5
South-east coast (Sandfell-Berufjord).....	4	-0.8	1.8	8.2	3.8	3.3
North-east coast (Skeggjastaðir-Grímsey)..	3	-3.0	-1.0	7.1	2.2	1.3
Interior districts (with the exception of Mödrudalur).....	5	-3.5	0.4	9.0	2.3	2.1
Plateau (Mödrudalur).....	1	-7.2	-2.1	8.4	-0.7	-0.4
The whole island	17	-2.4	0.8	8.7	2.9	2.5

Table IV shows that the climate of the interior districts is more continental than that at the coast, the summers being warmer and the winters colder. The differences in the temperature of the stations at the head of a fjord is greater than of those situated outside: Berufjord, for instance, is warmer than Papey. There are, however, exceptions to this in places where cold currents and drift-ice exert an influence; thus Bordeyri at the head of Húnaflói has the same annual temperature as Grímsey, — Raufarhöfn and Skeggjastaðir are even colder, being much influenced by the Polar currents.

During a period of 33 years (1873—1906) there have been on an average 166 frosty days annually at Stykkisholm, 109 in the Vestmannaeyjar, 158 at Berufjord and 192 on Grímsey. At Stórinupur near the southern lowlands, at a height of 135 metres above sea-level, during a period of 20 years, there have been on an average 200 frosty days. The frost appears early and disappears late. Frosty days are frequent till far into early summer, but in South and West Iceland midsummer is usually free from frost. On Grímsey it freezes in all the months of the year, but in July and August there are on an average only two frosty days monthly; at Berufjord, in the Vestmannaeyjar and at Stykkisholm, July has been free from frost during a period of 33 years. On the northernmost peninsulas and in districts situated at the highest levels there is no doubt that none of the months is entirely free from frost. When drift-ice lies along the coast in North Iceland the ground is usually frost-bound throughout summer, and in the vast extents of bog-land on the plateau, at a height of 400—500 metres the sub-surface ice never thaws entirely.

Table V shows the temperature at all the meteorological stations in Iceland during the years 1874—1901. The observations from the chief stations extend over a period of more than 25—28 years; at other stations 15—22 years and in some 5—12 years. For the sake of completeness some observations from three stations have been included, although they cover a period of 2—3 years only. Table VI gives many more and fuller information regarding temperature-conditions at the main stations during a period of 33 years (1872—1906).

The climate of Iceland is very damp although the precipitation is not considerable; it is, however, much greater than in Denmark. Sleet and drizzling rain are of constant occurrence, but the amount of precipitation on a single day is rarely sufficient to be of any con-

	Number of years	January	February	March	April	May	June	July	August	September	October	November	December	Winter	Spring	Summer	Autumn	Average for year
Stykkishólmur	28	-1.9	-2.3	-2.2	0.9	4.4	8.1	9.9	9.4	7.3	3.6	0.8	-1.5	-1.9	1.0	9.1	3.9	3.0
Borðeyri	12	-3.7	-4.0	-3.9	-0.3	3.0	6.8	8.1	8.1	6.1	2.3	-0.9	-3.1	-3.6	-0.4	7.7	2.5	1.6
Gilsbakki	7	-3.9	-3.7	-3.8	-0.4	4.0	7.9	9.4	8.6	6.1	1.6	-1.4	-3.5	-3.7	-0.1	8.6	2.1	1.7
Grímsey	27	-2.1	-2.8	-3.8	-1.2	1.9	5.4	7.1	7.0	5.8	2.4	0.1	1.4	-2.1	-1.0	6.5	2.8	1.6
Ákureyri	19	-3.2	-3.2	-3.5	0.8	4.7	9.0	10.4	9.3	6.3	2.0	1.0	-3.0	-3.1	0.7	9.6	2.4	2.4
Núpuvell	5	-4.4	-3.9	-4.0	0.8	4.5	9.3	9.5	9.4	6.0	1.5	-2.2	-4.5	-4.3	0.4	9.4	1.8	1.8
Rauðarhöfn	12	-3.8	-4.0	-4.9	-1.0	1.9	6.1	8.2	7.5	4.9	2.4	-1.5	-3.1	-3.6	-1.3	7.3	1.9	1.1
Skeggjastaðir	5	-3.7	-3.3	-4.2	-0.5	2.5	7.3	8.2	7.4	5.9	1.3	-1.3	-2.7	-3.2	-0.7	7.6	2.0	1.4
Móðrudalur	15	-7.8	-7.0	-7.2	-2.1	2.9	8.2	9.9	7.2	3.9	-1.4	4.7	-6.8	-7.2	-2.1	8.4	-0.7	-0.4
Berufjörður	28	-1.3	-1.2	-1.8	1.3	4.1	7.1	8.7	8.4	6.7	3.2	0.9	-0.8	-1.1	1.2	8.1	3.6	3.0
Papey	27	-1.1	-1.1	-1.9	0.5	2.7	5.2	6.7	6.9	5.9	3.1	1.0	-0.5	-0.9	0.4	6.3	3.3	2.5
Bjarnanes	8	-1.2	-0.8	-0.9	3.2	5.4	8.2	9.8	9.2	7.3	3.6	0.8	-0.9	-1.0	2.6	9.1	3.9	3.7
Sandfell	5	-0.7	-0.1	-0.1	3.4	5.8	8.6	9.8	9.2	7.4	4.0	1.2	-0.3	-0.4	3.0	9.2	4.2	4.0
Vestmannaeyjar	25	1.1	1.4	1.4	4.1	6.7	9.2	10.9	10.5	8.3	5.2	3.1	1.1	1.2	4.1	10.2	5.5	5.3
Stórinúpur	18	-3.0	-2.4	-2.5	1.7	5.6	8.9	10.8	9.3	6.7	2.2	-0.7	-3.1	-2.8	1.6	9.7	2.7	2.8
Eyrbakkí	21	-2.1	-1.5	-1.6	2.4	6.1	9.3	11.0	10.3	7.5	3.0	0.2	-2.1	-1.9	2.3	10.2	3.6	3.6
Hafnarfjörður	22	-1.5	-0.9	-0.9	2.7	6.1	9.3	11.0	10.5	7.6	3.5	0.7	-1.5	-1.3	2.6	10.3	3.9	3.9
Reykjavík	27	-1.1	-0.8	-0.5	3.1	6.4	9.7	11.2	10.6	7.8	3.9	1.2	-1.2	-1.0	3.0	10.5	4.3	4.2
Adalvík	2	-4.8	-4.1	-3.8	-1.1	3.1	7.1	9.6	7.5	5.9	2.1	-1.8	-3.3	-4.1	-0.6	8.1	2.1	1.4
Kórætsstaðir	3	-3.3	-3.1	-3.9	-0.2	3.2	7.9	9.9	8.2	6.3	1.5	-0.9	-2.9	-3.1	-0.3	8.7	2.3	1.9
Valbjófsstaður	3	-2.8	-2.9	-3.5	1.7	4.9	8.9	11.2	9.4	7.2	2.9	-0.7	2.5	-2.7	1.0	9.8	3.1	2.8
Mean for the northern half of Iceland		-3.8	-3.8	-4.2	-0.4	3.3	7.6	9.0	8.2	5.8	1.7	-1.3	-3.3	-3.5	-0.4	8.3	2.1	1.6
Mean for the southern half of Iceland		-1.2	-0.8	-1.0	2.4	5.3	8.2	9.8	9.3	7.2	3.5	0.9	-1.0	-1.0	2.2	9.1	3.9	3.6
Mean for the whole island (17 stations)		-2.6	-2.4	-2.7	0.9	4.3	7.9	9.4	8.7	6.5	2.6	-0.3	-2.2	-2.4	0.8	8.7	2.9	2.5

Stykkishólmur																
From 1/16 1873 to 31/12 1906.																
Mean temperature.....	— 2.0	— 2.4	— 2.2	0.7	4.3	8.2	9.9	9.3	7.3	3.5	0.7	— 1.4	— 1.9	0.9	9.1	3.8
Highest mean temperature....	0.9	0.9	2.9	4.8	7.1	10.2	12.4	12.0	9.8	6.8	3.2	1.5				3.0
Lowest mean temperature....	— 8.6	— 9.6	— 13.3	— 4.1	1.5	5.8	8.1	6.4	5.4	0.4	— 2.0	— 7.9				4.0
Absolute maximum temperature	9.7	8.9	9.6	12.3	19.9	19.9	22.9	22.0	16.2	15.1	11.4	10.4				1.3
Absolute minimum temperature	— 26.0	— 22.5	— 25.0	— 21.0	— 8.2	— 2.0	0.8	— 1.2	— 4.7	— 8.6	— 17.9	— 21.1				22.9
Mean maximum temperature..	0.6	0.1	0.6	3.4	7.2	11.1	12.7	12.0	9.7	5.7	2.9	1.0				26.0
Mean minimum temperature..	— 5.0	— 5.5	— 5.3	— 2.1	1.6	5.5	7.3	6.7	4.7	1.0	— 2.0	— 4.3				
Vestmannaeyjar																
From 1/17 1877 to 31/12 1906.																
Mean temperature.....	1.3	1.3	1.4	4.0	6.3	9.0	10.6	10.2	8.2	5.1	3.0	1.2	1.3	3.9	9.9	5.1
Highest mean temperature....	3.2	3.7	5.4	6.5	8.7	10.4	12.7	12.3	9.9	7.3	5.6	3.6				5.9
Lowest mean temperature....	— 1.7	— 2.4	— 3.0	— 2.4	4.0	7.2	9.1	9.0	6.3	2.7	0.4	— 3.2				4.1
Absolute maximum temperature	9.7	10.4	10.6	12.4	16.1	21.2	19.6	18.5	16.4	13.1	10.9	10.0				21.2
Absolute minimum temperature	— 17.4	— 15.2	— 20.9	— 13.3	— 9.5	— 0.8	2.7	— 0.3	— 2.6	— 6.6	16.1	— 16.0				20.9
Mean maximum temperature..	3.8	3.9	4.3	6.9	9.8	12.7	14.1	13.8	10.8	7.3	5.4	4.0				
Mean minimum temperature..	— 1.8	— 1.8	— 1.6	1.1	3.8	6.8	8.2	7.6	5.8	2.2	0.3	— 1.5				
Berufjörður																
From 1/12 1873 to 31/12 1906.																
Mean temperature.....	— 1.3	— 1.3	— 1.5	1.3	4.0	7.2	8.7	8.3	6.8	3.2	0.9	— 0.7	— 1.1	1.3	8.1	3.6
Highest mean temperature....	1.6	1.9	2.4	5.2	7.1	9.4	10.3	10.7	8.9	5.3	3.6	2.1				3.0
Lowest mean temperature....	— 8.5	— 5.7	— 9.4	— 3.3	1.7	4.7	6.4	6.1	4.6	0.6	— 2.4	— 6.7				4.2
Absolute maximum temperature	13.2	12.3	12.2	14.9	20.4	25.4	26.3	23.5	20.5	16.4	12.4	11.5				1.0
Absolute minimum temperature	— 23.1	— 19.3	— 21.9	— 18.3	— 10.8	— 4.2	0.8	— 2.9	— 5.8	— 10.3	17.4	— 20.4				26.3
Mean maximum temperature..	1.7	1.6	1.6	4.4	7.8	11.3	12.8	11.9	9.7	5.6	3.4	1.9				23.1
Mean minimum temperature..	— 4.1	— 4.2	— 4.9	— 1.7	1.1	4.1	5.9	5.5	4.2	0.7	— 1.8	— 3.5				
Papey																
From 1/12 1873 to 31/12 1906.																
Mean temperature.....	— 0.9	— 1.2	— 1.7	0.5	2.7	5.4	6.8	7.0	6.0	3.1	1.1	— 0.4	— 0.8	0.5	6.4	3.4
Highest mean temperature....	1.7	2.0	2.4	4.7	4.9	7.5	8.5	9.6	7.9	5.1	3.4	2.1				2.4
Lowest mean temperature....	— 8.3	— 5.3	— 8.8	— 3.1	— 0.2	3.0	4.5	4.2	3.8	0.2	— 2.2	— 6.4				3.7
Grímsey																
From 1/17 1873 to 31/12 1906.																
Mean temperature.....	— 2.0	— 3.0	— 3.6	— 1.2	1.7	5.5	7.0	6.8	5.7	2.5	0.0	— 1.3	— 2.1	— 1.0	6.4	2.7
Highest mean temperature....	1.6	1.2	1.4	3.3	5.1	8.5	10.1	10.8	8.5	4.7	2.8	2.1				1.5
Lowest mean temperature....	— 13.1	— 10.7	— 16.5	— 7.1	— 0.7	1.7	3.7	2.2	3.7	— 0.3	— 3.8	— 9.0				3.1
Absolute maximum temperature	9.5	8.8	9.6	10.8	16.0	21.0	19.6	26.2	18.3	12.9	11.2	9.9				26.2
Absolute minimum temperature	— 30.0	— 25.0	— 30.0	— 23.8	— 12.2	— 6.9	— 3.0	— 3.0	— 5.0	— 11.0	17.5	— 20.4				30.0
Mean maximum temperature..	0.5	0.3	0.6	1.2	4.1	8.5	9.9	9.6	7.9	4.2	2.0	1.1				
Mean minimum temperature..	— 4.8	— 5.6	— 6.0	4.0	— 0.5	3.0	4.8	4.7	3.1	— 0.3	— 2.7	— 4.1				

sequence. As the rainfall, however, is often accompanied by storms, the weather is frequently very unpleasant for man and beast. It is especially in South Iceland that complaints are heard of the storms of sleet during autumn, when everything becomes saturated with moisture and rain penetrates into the houses through every chink and crevice. The humidity is more considerable in South than in North Iceland, which is shown for instance by the fact that houses with turf walls must be rebuilt more often in the southern districts. A cold, damp, whitish fog, accompanied by sleet, is very characteristic of the northern headlands, especially when the Greenland ice drifts backwards and forwards along the coast; then fog may shroud the coast for weeks and extend far into the valleys. The fog persists for a long time also in other places along the coast, especially in East Iceland. The amount of cloud also is generally great, especially in North Iceland.¹

The amount of rainfall varies greatly in the different parts of Iceland, and in most places it is generally greatest during autumn and winter; on Grímsey, however, it is greatest during summer and autumn. The precipitation is greatest along the south and south-east coasts: in the Vestmannaeyjar 1320 mm., and at Berufjord 1166 mm. The greatest amount of annual rainfall in the Vestmannaeyjar was 1587 mm., and at Berufjord 1737 mm. Along the west coast the rainfall is much less, and still less in North Iceland, being at Stykkisholm 656 mm., but on Grímsey only 345 mm. At Stykkisholm there are, however, on an average 207 rainy days, but on Papey only 135, consequently, a much greater amount of rain falls there at a time. At Berufjord the greatest amount of rainfall within 24 hours was 109½ mm. (July); at Stykkisholm 51.9 mm. (January); and on Grímsey 34.3 mm. (November). Heavy showers and sudden torrents of rain do enormous damage to the soil-layer on the mountain-sides, which are usually woodless and unprotected, and occasion numerous rock-slips which have often proved very disastrous to property and human life. The frequency of fogs differs greatly at different parts of the coast, but it is most frequent along the southern part of the east coast where the warm and cold ocean currents meet. At Berufjord there are on an average 171 foggy days annually; here fogs are frequent at all the periods of the year, but they occur most frequently during summer. On Papey (in the neighbourhood

¹ Amount of cloud (0—10): Vestmannaeyjar 6.2; Stykkisholm 6.7; Berufjord 6.7; and Grímsey 8.3.

Table VII. Amount of Precipitation along the

	January	February	March	April	May
Stykkishólmur					
From $\frac{1}{8}$ 1873 to $\frac{31}{12}$ 1906.					
Mean precipitation	78.2	65.5	45.0	34.6	38.6
Highest amount for the month	184.0	217.2	116.6	67.0	132.0
Lowest amount for the month	17.5	6.0	10.7	4.2	2.0
Greatest amount of precipitation during 24 hours	51.9	50.1	19.2	17.6	19.8
Number of days with snow	16	14	13	8	3
— fog	0.3	0.5	0.4	0.7	2.0
— frost	26	25	26	19	9
— storm	6	6	6	4	4
— precipitation	21	19	18	16	15
Vestmannaeyjar					
From $\frac{1}{7}$ 1877 to $\frac{31}{12}$ 1906.					
Mean precipitation	133.6	108.5	110.2	92.1	77.9
Highest amount for the month	225.6	195.1	239.0	198.1	149.1
Lowest amount for the month	34.5	29.6	26.1	15.0	11.5
Greatest amount of precipitation during 24 hours	41.8	54.8	62.6	33.6	46.9
Number of days with snow	9	8	8	4	1
— fog	2	2	2	3	5
— frost	20	18	17	10	3
— storm	4	3	3	2	1
Berufjörður					
From $\frac{1}{12}$ 1872 to $\frac{31}{12}$ 1906.					
Mean precipitation	122.8	95.6	76.1	88.0	70.8
Highest amount for the month	258.7	214.9	231.6	222.9	237.6
Lowest amount for the month	26.6	4.6	2.6	15.0	0.0
Greatest amount of precipitation during 24 hours	57.2	59.0	62.6	44.8	52.6
Number of days with snow	8	8	9	5	3
— fog	11	11	11	14	17
— frost	24	22	25	18	10
Papey					
From $\frac{1}{8}$ 1873 to $\frac{31}{12}$ 1906.					
Number of days with precipitation	14	13	12	12	9
— snow	7	7	7	5	3
— fog	9	9	10	12	13
Grímsey					
From $\frac{1}{7}$ 1873 to $\frac{31}{12}$ 1906.					
Mean precipitation	21.5	22.2	22.5	15.9	19.3
Highest amount for the month	58.0	112.0	73.8	37.5	98.7
Lowest amount for the month	1.2	0.6	2.4	1.2	3.0
Greatest amount of precipitation during 24 hours	16.5	20.4	13.8	16.1	28.1
Number of days with snow	7	8	8	7	5
— fog	1	1	2	4	6
— frost	25	24	27	24	17
— storm	2	1	1	0.3	0.2

nd in millimetres for the Period 1872—1906.

August	September	October	November	December	Winter	Spring	Summer	Autumn	Average for year
39.2	72.7	71.5	69.6	63.6	207.3	118.2	116.6	213.8	655.9
129.6	149.3	152.2	126.7	125.5					
3.2	20.1	19.4	20.4	11.7					
24.4	50.5	31.8	34.4	23.6					
	1	4	10	14	44	24	1	15	84
1.3	0.7	0.3	0.4	0.3	1	3	4	1	9
0.1	1	13	20	26	77	54	1	34	166
2	4	5	5	5	17	14	5	14	50
14	18	18	19	20	60	49	43	55	207
77.9	142.6	135.5	132.2	141.4	383.5	280.2	245.6	410.3	1319.6
226.7	215.9	241.2	244.0	296.1					1586.8
13.2	48.3	61.7	50.9	50.6					946.4
51.4	54.8	59.4	58.0	41.4					62.6
	0.3	2	4	8	25	13	0.2	6	44
6	5	4	2	2	6	10	22	11	49
0.4	1	8	13	19	57	30	0.1	22	109
0.3	2	2	3	4	11	6	1	7	25
79.2	128.0	118.0	113.9	132.8	351.2	234.9	219.8	359.9	1165.8
225.5	314.4	267.7	245.9	331.4					1737.1
8.1	6.1	9.7	9.3	1.8					571.5
64.5	72.5	55.9	56.2	83.4					109.5
0.1	0.5	3	6	7	23	17	0.5	9.5	50
18	16	12	11	10	32	42	58	39	171
0.3	2	13	18	24	70	53	2	33	158
8	11	12	14	14	41	33	24	37	135
	1	3	5	6	20	15	1	9	45
16	12	11	10	8	26	35	49	33	143
38.8	41.7	44.7	36.8	24.9	68.6	57.7	95.1	123.2	344.6
139.0	75.0	185.9	154.0	66.9					
0.8	7.4	13.4	4.2	0.0					
20.2	32.0	32.3	34.3	17.6					
0.4	2	6	9	9	24	20	3	17	64
8	4	2	0.5	0.3	2	12	25	6	46
2	4	17	21	24	73	68	9	42	192
0.2	1	1	2	2	5	1.5	0.8	4	11

of Berufjord) there are 143 foggy days. In other places fogs are much rarer; for instance on Grímsey there are on an average 46 foggy days, the majority of which occur during summer, while at Stykkisholm there are only nine. Along Hornstrandir fogs are very common especially during ice-years, but from this locality no observations are to hand.

The amount of snow varies greatly according to situation and height above sea-level, and from year to year. In North Iceland snow often persists for a long time during winter, but in south-west Iceland the weather is always stormy and unsettled; consequently, in the lowlands the winter-snow rarely persists for a long time. Frost and thaw often alternate daily. In South Iceland it often happens during winter that no snow is to be seen for months in the lowlands. On the other hand, it rains very often, and the precipitation which falls here as rain, produces on the plateau considerable masses of snow. By way of exemplifying the durability of the snow-covering, I give the results of my observations — the number of days with snow-covering — in Reykjavík during the winters of 1889—1892 and 1893—1895 in the following table: —

	1889—90	1890—91	1891—92	1893—94	1894—95
September	0	0	0	2	0
October	2	4	1	2	1
November	9	10	10	5	2
December	23	12	26	27	23
January	31	13	25	14	18
February	15	13	29	28	3
March	16	30	24	14	8
April	0	2	6	0	5
	96	84	121	92	60

In these five winters it snowed for the first time on Oct. 28, Sept. 28, Oct. 24, Sept. 19 and Oct. 31 respectively; for the last time on March 20, April 18, April 26, March 30 and April 18. Very often the snow persisted for a day or two only. The longest period during which the ground was covered continually with snow, was in the winter of 1891—92, viz. 63 days, from Jan. 19 to March 21. In all these winters the neighbouring Akrafjall, which has an altitude of 364 metres was often entirely snowless. In several places in North

Iceland the snow-covering persists so long during winter, that all intercourse between the farmsteads takes place on snow-shoes, and goods are transported on sledges, but in South Iceland sledges are hardly ever seen and still less snow-shoes. Snow may fall in any of the summer months, but in South Iceland it is only rarely that there is snowfall of any consequence during summer. In the northernmost districts it happens now and then, especially when Polar ice is in the vicinity of the island, that it snows so heavily for some days during mid-summer, that haymaking is suspended and the cattle must be stabled for a shorter or longer time. On the plateau snow-storms accompanied with frost occur now and then in July and August, and upon the great ice-mountains (Jökulls) it often snows in all months of the year. During a period of 30 years it snowed on an average 84 days annually at Stykkisholm, 44 days in the Vestmannaeyjar, 50 days at Berufjord, 45 days on Papey and 64 days on Grímsey. The amount of snow, as already mentioned, varies greatly according to the year. Snow-storms during winter have often caused great disasters by destroying thousands of sheep and many human lives. The annals of Iceland give us much information of such disasters, and numerous written records of many centuries show that the climate of Iceland has not changed since its first colonization in the year 874.

Hail is fairly common during winter, but rare during summer. On Grímsey it hails about twenty-four times annually; in the Vestmannaeyjar twenty times, at Stykkisholm five times and on Papey twice. The hail-stones are as a rule small, rarely larger than grit; but during volcanic eruptions, they are much larger, and often include grains of volcanic sand or ashes. Thunder is very rare and occurs as a rule only in winter. The registered thunderstorms average two in the year in the Vestmannaeyjar, and only one at Stykkisholm and Berufjord, while none have ever been registered on Grímsey. On the whole, thunderstorms are extremely rare in northern Iceland; thus at Audkula vicarage, in the district of Húnavatnssýsla, thunder was heard once only between 1857 and 1873. Thunderstorms are more common along the southernmost part of the coast (Eyjafjöll, Landeyjar, Rangárvellir) where they occur sometimes during the summer also. The volcanic eruptions are almost always accompanied by thunder and strong electrical discharges.

The climatic conditions we have hitherto been considering, have naturally been those connected especially with the coasts and the

inhabited districts, because there alone permanent meteorological stations are found. The climate of the uninhabited plateau is far less known. Although it is possible, from the climate at the coast, to draw fairly definite conclusions as regards the climate of the interior, derived from the height above sea-level and the distance from the coast, yet almost all accurate investigations and observations from the plateau are wanting. The only climatological station on the plateau is Möðrudalur (469 metres above sea-level), and it will be seen that the climate there is far more severe than at the coast (see Table IV), from which again may be concluded how very severe must be the winter up at the Jökulls in the centre of the island, at a height of 1000—1400 metres; the climate in the interior is certainly far more continental than at the coast. The winter in Möðrudalur (mean temperature -7.2° C.) is almost twice as severe as in the inhabited districts of North Iceland at any height up to 100 metres above sea-level, with a mean temperature of -3.5° C. The spring of Möðrudalur is very cold with a mean temperature of -2.1° C., and the mean autumn temperature is also below zero (-0.7° C.), but the summer is as warm as at the coast. On Odádhraun and north of Arnarfellsjökull the winter is beyond doubt very severe, with perhaps a mean temperature of -10° or less. That the frost persists for a long time is seen by a few small oases, where the snow does not thaw until during July and where a miserable vegetation appears only for a period of two months. On the plateau the storms blow with great force, driving sand, gravel and small rock-fragments across the desolate plains and ridges of rock, thereby striating and polishing them; as mentioned above, the wind also carries great quantities of tuff-dust and blown sand from the plateau down to the valleys and lowlands. During summer it may sometimes become fairly warm in the middle of the day, but, in the interior of the plateau, it usually freezes during the night, so that small water-courses and pools of water are ice-covered early in the morning. Snow-storms occur now and then, and sand- and rain-storms and fogs are very common. The large Jökull-domes in the centre of the plateau often appear to form a climatic boundary, the weather frequently being opposite in character to the north and south of them. Thus, there is often bright sunshine on Arnarvatnsheiði, north of Langjökull, while south-easterly storms of rain are raging over the plateau south of the same Jökull; conversely it may be warm sunshiny weather on the

southern side, while fogs, with sleet and cold, extend from Húnaflói to the plateaus north of Langjökull. In a similar manner the mountain ranges on Reykjanes and Snæfellsnes exert great influence upon the local weather-conditions in the districts on either side of them. Apart from this, the weather often varies greatly in the different parts of the coast — a storm may be blowing on the south coast, while it is calm on the north coast. Northerly winds usually bring snow or rain to North Iceland, while they bring clear weather upon the south coast; southerly winds bring rain or snow-squalls to South Iceland and almost always an overcast sky, while simultaneously it is clear weather in North Iceland. The weather may differ in the fjords: a storm may be blowing out of the fjord, while it is calm outside, and vice versa. Sudden and strong gusts of wind blowing down from the mountains are often dangerous in some fjords, and in mountainous districts, highly intersected by valleys and ravines, the conditions of weather in the different districts are very capricious. On the whole, the weather-conditions on Iceland are very variable and unreliable in character.

IV. ACCOUNT OF THE GENERAL DISTRIBUTION OF PLANT-LIFE.

In connection with the description of the physiographical and climatic conditions, I shall now try to give a very brief account of the distribution of plant-life on the rocky substratum of Iceland. The following should be regarded merely as an attempt towards a description of the main features for general orientation. It is expected that later on in this work a more accurate and detailed account of the plant-geographical conditions will be given, and the ecological conditions and the different plant-formations will be described and analysed by different specialists.

Geological investigation has proved that Iceland in early Tertiary times was in all probability connected with Greenland and with Scotland across the Færøes by a land-bridge of volcanic, especially basaltic, rocks; the depression of this land-bridge had probably occurred and the countries been separated even in the Miocene period. During Pliocene times Iceland was somewhat larger than it is now, but subsidence continued; during this period the submarine coastal platform was formed, which occurs around the whole island, and also the now submarine fjord-grooves which lead off from the mouths of the present-day fjords. At the end of Pliocene times the climate gradually became colder until the Glacial period laid a continuous snow-covering over the whole island. Some botanists are of the opinion that a land-bridge connected Iceland and the Færøes with Greenland and Scotland during post-Glacial times also, but this hypothesis is highly improbable as it is at variance with many geographical and geological facts which are enumerated in the works cited below.¹ No geologist who is closely acquainted with the

¹ Th. Thoroddsen: Hypothesen om en postglacial Landbro over Island og Færøerne, set fra et geologisk Synspunkt. Ymer, Stockholm, 1904, pp. 392—399. Endnu nogle Ord om Landbro-Hypothesen. Ymer, 1906, pp. 93—101. Naturwissenschaftliche Rundschau, XXI Jahrg., No. 31. Island. Grundriss der Geologie und

geology of Iceland has been able to find any support for this hypothesis.

The Tertiary vegetation — probably from Eocene and Miocene times — which, as already mentioned, is found in the clay beds and in the so-called “Surtarbrand” in the middle of the basalt formation, was probably much altered in character even in Pliocene times, but unfortunately from this period there has as yet been found only a few small and undeterminable fragments of plants (conifers). When the Glacial period buried Iceland beneath an icy covering the Tertiary flora died out entirely, and the present flora must consequently have immigrated after the Glacial period and perhaps even partially during it, in intervening milder periods when the glaciers retreated slightly. As yet there are no real proofs to hand of an interglacial period in Iceland when the country was entirely free from ice and partially plant-covered.

As already mentioned, only a very small part of Iceland is really plant-covered. The continuous carpets of vegetation are only of slight extent compared with the considerable area of the island, and even in low-lying, inhabited districts large areas are occupied by rocky flats, *Grimmia*-heaths, sandy stretches poor in plant-life, lava-streams, etc. This is of course primarily due to the northerly situation of the island and the climatic conditions. The climatological chapter shows that the climate of Iceland is raw and cold. The winter is long, but generally not very severe; the summer is comparatively short and cold and the weather is usually changeable and damp; during spring, cold winds and sea ice accompanied by fogs do great damage as they often occur in the beginning of the growth-period. In many places the plants — many of which are evergreens — are protected from the cold of winter by a lasting snow-covering, but, as we have seen in the above, in several districts, especially in South Iceland, this snow-covering is variable and of short duration so that plant-growth suffers greatly under the influence of the cold wind; it is easily seen that there is great difference in the vegetation of the bare gravelly flats where the snow drifts off and of the depressions and localities in the shelter of rocks where the snow persists. Differences in the temperature and weather conditions of the different years according to whether Polar ice visits the coast or not, are of the greatest importance to plant-life.

The snow-coverings in the lowlands generally melt away in April and the period of growth begins in May. But the time for the appearance of the plants differs considerably throughout the extent of the island, not only according to position and height above sea-level, but also on account of the conditions of weather in different years.

In south-west Iceland, in the neighbourhood of Reykjavík, in somewhat favourable years a few species flower at the end of April, e. g. *Saxifraga oppositifolia* and *Arabis petræa*, but in the beginning of May a great many plants are in bloom, e. g. *Salix herbacea*, *Alchimilla alpina*, *A. vulgaris*, *Draba incana* and *Silene acaulis*, somewhat later and until the middle of the month *Caltha palustris*, *Cardamine pratensis*, *Armeria maritima*, *Rumex acetosa*, *Oxyria digyna* and at the end of the month *Ranunculus acer*, *Taraxacum vulgare*, *Cerastium alpinum*, *C. vulgare*, *Thalictrum alpinum*, *Arctostaphylos uva ursi*, *Pinguicula vulgaris*, *Betula nana* and others. The common flowering period begins in June; and June and July are the months richest in flowers. For the rest, the flowering period is highly dependent on the weather; it may be delayed in colder years, especially in ice-years, but on the other hand, during prolonged periods of thaw in winter some flowers may open in February and March. On the northernmost points of land and on the plateau the time for flowering is naturally somewhat later.¹

The number of plant-species found in Iceland cannot yet be stated with any certainty, but later in this work the lists and collections will be critically investigated and new species added to the list.² The number of species of known phanerogams and vascular

¹ For observations regarding the time of flowering in East Iceland in 1893 and 1894 see Helgi Jónsson: Vinter- og Vaar-Ekskursioner i Øst-Island (Botanisk Tidsskrift, 1895, pp. 274—275 and 292—294), and in the neighbourhood of Reykjavík in 1873—1875 see Th. Thoroddsen's notes in Grönlund's Karakteristik af Plantevæksten paa Island, pp. 17—18. Moreover, there are some notes on the subject which have not as yet been published; but they make no difference as regards the general sketch of the spring-flowering given here.

² The chief floristic works on Iceland are the following: — St. Stefánsson: Flóra Islands, København, 1901. W. Lauder Lindsay: Flora of Iceland. (New Philosophical Journal, New Series, Edinburgh, July, 1861; 40 pages). C. C. Babington: A Revision of the Flora of Iceland. (The Journal of the Linnean Society, Vol. XI, London, 1871, pp. 282—348). Chr. Grönlund: Bidrag til Oplysning om Islands Flora. Højere Kryptogamer og Phanerogamer. (Botanisk Tidsskrift, 2. Række, IV, 1874, pp. 36—85). Chr. Grönlund: Islands Flora. København, 1881. Chr. Grönlund: Afsluttende Bidrag til Oplysning om Islands Flora. (Bot. Tidsskr., XIV, 1885, pp. 159—217). H. F. G. Strömfelt: Islands kärlväxter. (Öfversikt af Kgl. Vetensk.

cryptogams may, I think, be estimated at 400—450. Chr. Grönlund in 1884 enumerated 366 species (340 + 26); E. Rostrup in 1887, 409 species (381 + 28); E. Warming in 1888, 417 (388 + 29); St. Stefánsson in 1890, 423 species (395 + 28), but in "Islands Flora," 1901, only 359 species; Helgi Jónsson recorded in 1896, 435 species, but in 1904, 360 species. It is thus seen that the number of the species differs somewhat according to the different authors: the reason for this I shall not enter into more closely here. For comparison it may be mentioned that the number of species known from the Færøes (Ostenfeld, Botany of the Færøes) is about 300 species of phanerogams and vascular cryptogams, from Greenland (E. Warming, 1888) 386 species, from Denmark about 1450 species, from Norway 1500. In the following I give an account for comparison and orientation: it is based on E. Warming's statistics (1888) and gives an excellent general idea of the subject, but it will probably be somewhat modified in its details on a later revision of the material. Warming records, according to what was known at that time of the flora of the island, that of circumpolar species there were found in Iceland 64, in Greenland 96 and in the Færøes 36; of sub-boreal and sub-alpine species in Iceland 70, in Greenland 87 and in the Færøes 33; and of temperate zonal species in Iceland 151, in Greenland 82 and in the Færøes 134. Of species which occur both in Europe and in America 48 are found in Iceland, 16 in Greenland, 47 in the Færøes; of those common to America, Europe and Spitzbergen 3 are found in Iceland, 5 in Greenland, 2 in the Færøes; in common with America alone Iceland has two species only, Greenland 21 and the Færøes none; in common with Europe there occur in Iceland 42, in Greenland 19 and in the Færøes 54 species. Greenland has 222 species in common with Iceland, but 137 with the Færøes; on the other hand, Iceland and the Færøes

Akad. Föreläsningar. Stockholm, 1884, pp. 79—124). E. Rostrup: Bidrag til Islands Flora. (Bot. Tidsskrift, XVI, 1888, pp. 168—186). Stefán Stefánsson: Fra Islands Væxtrige, I. III. (Vidensk. Meddelelser fra Naturh. Foren. i København, 1890, pp. 166—181; 1894, pp. 174—212; 1896, pp. 118—153). O. Gelert og C. Ostenfeld: Nogle Bidrag til Islands Flora. (Botan. Tidsskrift, XXI, 1898, pp. 339—348). Helgi Jónsson: Bidrag til Øst-Islands Flora. (Bot. Tidsskr., XX, 1896, pp. 327—357). Helgi Jónsson: Floraen paa Snæfellsnes og Omegn. (Bot. Tidsskr., XXII, 1899, pp. 169—207). Helgi Jónsson: Liste over Karkryptogamer og Phanerogamer i Syd-Island. (Bot. Tidsskr., XXVII, 1905, pp. 62—82). As regards older botanical literature, see Bibliogr. in E. Warming: Den danske botaniske Literatur fra de ældste Tider til 1880 (Botanisk Tidsskrift, XII, pp. 42—131, 158—247) and in Th. Thoroddsen: "Landfrøedssaga Islands," Vol. 4, Copenhagen, 1904. ■

have 237 species in common. Of the higher plants in Iceland the majority of the species belong to the Cyperaceæ (44) and the Gramineæ (40), and these two families are also most characteristic of the inhabited land and of the greatest importance as regards the sustenance of the inhabitants. Of Compositæ there are 25 species, of Caryophyllaceæ 24, Cruciferae 22, Juncaceæ 17, Filices 17, Rosaceæ 16, Scrophulariaceæ 13, Papilionaceæ 12, etc.¹ The lower plants have not yet been closely investigated; there are known, however, 300 species of mosses, 233 species of lichens and 543 species of fungi, 452 of which are parasites; on *Betula odorata* have been found 54 species of parasites, on *Salix lanata* 14 species, on *Dryas octopetala* 11, and on *Betula nana* and *Salix glauca* 10, etc. The mushrooms, of which many occur, are as yet but slightly known.²

Naturally, nothing is known as to how many species have immigrated into Iceland since the first colonization of the island in 874, but we may take for granted that the number is considerable. Even by the first "Landnámsmen" several species were undoubtedly imported from Norway and perhaps also from the islands along Scotland. In the Sagas we read about live-stock (cows, horses, sheep and swine) being brought to Iceland and in the fodder brought along with them there were certainly several foreign seeds. Some of the immigrants for religious reasons, brought earth with them from Norway from the site of their former temple (Hof). Then the settlers also used foreign seed for cereal crops, on the cultivation of which they were very keen at first. Moreover, different species may have been introduced along with articles of commerce and in other ways. Of imported species, which during later centuries have gained a firm footing and have become naturalized, the most common are *Urtica urens*, *U. dioeca*, *Cirsium arvense*, *Spergula arvensis*, *Carum carvi*, *Lamium intermedium*, *Senecio vulgaris* and some others.

¹ Eug. Warming: Tabellarisk Oversigt over Grönlands, Islands og Færøernes Flora, 1887. (Vidensk. Meddel. fra den naturhist. Foren., 1887, Köbenhavn, 1888).

² Chr. Grönlund: Islandske Naturforhold med særligt Hensyn til Mosvæxtens Betydning for Landskabet (Tidsskrift for populære Fremstillinger af Naturvidenskaben. 5. Række, IV, 1877, pp. 321—356). Bidrag til Oplysning om Islands Flora, Lichenes, Hepaticæ og Musci (Bot. Tidsskr., IV, 1870, pp. 147—172; 2. Række, III, 1873, pp. 1—26). Afsluttende Bidrag til Oplysning om Islands Flora, Musci, Hepaticæ, Lichenes (Bot. Tidsskr., XIV, 1885, pp. 159—217). Tillæg til Islands Kryptogamflora, indeholdende Lichenes, Hepaticæ og Musci (Bot. Tidsskr., XX, 1895, pp. 90—115). Islandske Svampe samlede 1876 af Chr. Grönlund (Bot. Tidsskr., XI, 1879—80, pp. 72—76). E. Rostrup: Islands Svampe (Bot. Tidsskr., XIV, 1885, pp. 218—229; XXV, 1903, pp. 281—335).

Lastly some 40—50 foreign species have been found which have not yet gained a permanent footing in the flora, some of which will probably again disappear.

There can be no doubt that the vegetation has been modified in various ways since man with his cattle-rearing came upon the scene; sheep have especially exerted a great influence upon the coppice-woods and other vegetation; in the few places to which sheep cannot gain access, e. g. in distant valleys surrounded by glaciers and rivers of great volume, on islands in the middle of waterfalls or torrential rivers or in lakes the vegetation is usually far more luxuriant than in other places. In Viðidalur in Lón I had the opportunity of noting an example of the change effected by sheep-rearing. The locality in question is situated 439 metres above sea-level and has a southern exposure; it is surrounded by glaciers and deep river-gorges impossible for sheep and cattle to cross. Formerly the valley had been inhabited for a short time, but in 1840 it was deserted by the inhabitants. I visited the valley in the cold summer of 1882 and found there a very luxuriant vegetation; all the plants had a height quite unusual in Iceland. At the bottom of the valley the grass and the different species of willow usually reached to the horse's belly; especially were *Salix phylicifolia*, *Geranium silvaticum*, *Bartsia alpina* and *Archangelica officinalis* of considerable size; there was almost a wood of *Archangelica* which reached a height of 1—2 metres. The old ruins of the huts which were destroyed in 1840 by an avalanche were overgrown with *Archangelica officinalis* and *Salix phylicifolia*, and from the old fire-place a willow, belonging to the latter species, had grown out, about 2 metres in height, with stem 3—4 cm. in diameter. In 1883 the valley was again inhabited. I revisited the place in the summer of 1894 and found the conditions greatly changed owing to cultivation and the influence of sheep and cattle. That tract of land upon which the above-mentioned species had reached their highest development was now laid out as a manured home-field (tun), overgrown by species of grass characteristic of manured fields. These grasses had not, however, yet gained mastery over the wild vegetation; the single plants of grass stood far apart, so that the field only yielded 64 cwt. hay per annum, while in the coastal districts a well cultivated field of the same size would have yielded 240 cwt. Besides, the soil was quite intersected by subterranean portions of former plants, roots of willows, etc. This vegetation would therefore in all probability quickly become

predominant if the farm were to be abandoned. Small willow-shrubs (*Salix phylicifolia* and *S. glauca*) had grown out from several pieces of turf which had been used for making the walls of the houses. On account of the large number of sheep the plant-growth of the whole valley had degenerated. The luxuriance had entirely disappeared; no plants of any height were to be seen, the willow shrubs had become smaller and flatter in growth, as during winter the sheep nibble off the uppermost shoots which protrude through the snow; here it had not been possible to procure sufficient hay for winter-fodder, therefore, during winter the sheep had been left to shift for themselves with the result that they had attacked the willow coppices and a neighbouring birch coppice in Kollumuli.

But the destruction of the coppice-woods has exerted the greatest influence upon the vegetation. The Icelandic author Ari fródi (born 1067) says in his "Íslendingabók" that when the first settlers came to Iceland it was wooded from the sea to the mountains or inner plateau ("milli fjalls ok fjöru"). But this statement is doubtless due to exaggeration. Arngrímur, the Abbot of Thingeyrar, writes in 1350 about Iceland "woods do not occur except birch, and that is low in growth." At the first colonization of Iceland many mountain-sides were probably coppice-clad right to the verge, likewise many ridges, gravelly stretches and old lavas on the plains, which are now bare. The coppices spread over a great part of the coastal districts and the valleys, but nowhere extended up on the plateau above a height of 600 metres, and probably even at that time the northern peninsulas and the extreme points of land were woodless. In the lowlands also many tracts of sand, bogs and new lavas were undoubtedly bare of wood as in the present time, and probably not more than 4000–5000 square km were covered with coppice at the beginning of the 10th century. The birch stems found in the bogs also show that the trees of olden times were not larger than those now found in the best preserved patches of wood. From the Sagas it can be seen that even during the first centuries the woods had suffered greatly. Space was cleared for farms and home-fields, and the best stems were used as laths for the support of the turf-roofs, etc., of smaller houses, although the greater part of the building-wood was imported from Norway, at any rate in districts where there was not easy access to drift-wood which at that time was found in quantities along the northernmost coasts. Moreover, trees were recklessly felled for fuel and in addition, wood in olden times

was largely used for the smelting of bog iron-ore and for charcoal for smith's work. Even as late as 1870 charcoal was used in every farmstead during hay-making for the purpose of beating out and sharpening the scythes. Numerous remains of ancient charcoal-pits are still to be seen in many places where no woods are found today. Burning woods are several times mentioned in the Sagas. They were set on fire either accidentally or also maliciously for revenge or out of mischief. But for centuries the sheep and goats have been the worst enemies of the woods; during winter when the snow is lying on the ground they procure their means of sustenance chiefly from the woods, nibbling off all the buds and gnawing the branches and stems. Even in the middle of the 13th century the greater part of the woods had disappeared from the inhabited districts, and the remnants have since that time been gradually diminishing. It is a wonder that woods still exist in Iceland to such an extent that, including shrubs, they cover an area of about 454 square km.¹ In the beginning of the 15th century all the copice-woods had disappeared from Hunavatns and Skagafjardarsyslur, but in Eyjafjardarsysla some remains of woodland persisted till the beginning of the 19th century. Now the whole stretch of land from Eyjafjörður to Hrutafjörður is devoid of wood. Even in the middle of the 18th century woods, fairly high in growth, existed in several places from which they have now disappeared; they were greatly damaged by the Katla and Laki eruptions of 1755 and 1783 respectively.

Generally speaking, it may be said that the same kind of vegetation prevails throughout the island; taken as a whole, there is no great difference between north and south, high and low. The character of the flora is the same everywhere, although on a closer inspection it will be seen that the composition of the plant-formations varies somewhat, and that certain species are peculiar to, or specially common in, certain districts. The different species vary extremely as regards the number of their individuals; true, the largest areas are covered with a continuous carpet of grasses, sedges, dwarf-willows, heathers and *Grimmias*, but some species characteristic of rocky flats, such as *Armeria maritima*, *Polygonum viviparum*, *Cerastium alpinum*, *Salix herbacea*, *Silene maritima*, *Oxyria digyna*, *Sibbaldia procumbens* and others, occur widely distributed as scattered individuals throughout the island from the coast to the snow-line. Ac-

¹ Landshagsskýrslur fyrir Ísland, 1911, Reykjavík, 1912, p. 89.

cording to St. Stefansson's "Flora Islands," where 359 species are described, 197 species are common all over the island, 37 common in a few districts, 72 species are rather rare, and 53 species very rare.

As already mentioned, the vegetation has a homogeneous character throughout the island, and — according to our present knowledge — there are only a few species which are especially characteristic of certain parts of the island. East Iceland (Múlassýslur) is most noticeable in this respect; also, plant-geographically, Austur-Skaftafellssýsla, which stretches as a narrow ribbon along the southern edge of Vatnajökull as far as to Skeidarársandur; this extensive sandy tract forms a limit for several of the eastern species. *Campanula rotundifolia* is a common characteristic plant in East Iceland, but very rarely so in other places; I found the most westerly individuals of this species on Brunasandur towards the southwest, and at Hólkná in the district of Thistilfjord towards the north, but it is very common east of these boundaries. *Saxifraga aizoides* is very common in East Iceland, but has not been found elsewhere — I found it in a most south-westerly direction at Øræfi and in a most north-westerly direction near Vidirhóll at Fjallasveit. *Trientalis europea* grows in various places in the coppice-woods of East Iceland, but nowhere else; *Alchimilla færoënsis* is also common in East Iceland, but has not been found elsewhere. *Cerastium Edmondstonii* has been found in some places in East Iceland and in one locality in Skaftafellssýsla. *Saxifraga Cotyledon* grows along the south-eastern coast from Foss in Sida to Eskifjord, and two species of rose, *Rosa pimpinellifolia* and *R. canina*, grow along the same stretch of coast and nowhere else; the former was found in three habitats, westernmost at Seljaland and easternmost at Reydarfjord; the latter was found only at Tvísker on Breidamerkursandur. *Lychnis flos cuculi* grows along the south coast from Eyjafjöll to Øræfi and has not been found in other districts.

In South and South-west Iceland several species are common which either are not found or are very rare in other districts. *Spiræa ulmaria* is common from Borgarfjord to Lónsheidi, rare in other places, and not found in Mulasýslur; *Brunella vulgaris* is very common in South Iceland, but very rare in other places; *Plantago lanceolata* is also common in South Iceland, but has otherwise been found only in a few places in North Iceland near hot springs. *Suc-cisa pratensis* is characteristic of South Iceland and is especially common in Vestur-Skaftafellssýsla, west of Brunasandur. *Valeriana*

officinalis, *Vicia sepium*, *Galeopsis Tetrahit* and *Sanguisorba officinalis* occur only in southern and south-western Iceland. *Anthyllis vulneraria* is fairly common in south-west Iceland, but has otherwise been found only in one place in East Iceland (Njardvik); *Cakile maritima* is common in the sea-sand in south-west Iceland and in the southern part of the north-western peninsula, but has not been found elsewhere. *Lathyrus paluster*, *L. pratensis* and *Veronica anagallis* have been found only in south-west Iceland, and *Haloscias scoticum*, also, does not grow in other places with the exception of the islands in Breidifjörður where it occurs rather frequently, and on the islands in Hornafjörður; *Hydrocotyle vulgaris* occurs near hot springs in South Iceland, especially in the district of Borgarfjörður, but has not been found elsewhere; *Zostera marina* is very common in south-west Iceland, but is rare in other places.

The plant life of the north-western peninsula is as a rule poor in species and not very characteristic. *Fragaria vesca* has not been found there, although it is fairly common all over the island; *Cornus suecica* grows in some places in Vestfirðir and near Breidifjörður, but has not been found elsewhere, and *Melampyrum silvaticum* has been found only in wooded valleys near Isafjörður. *Papaver nudicaule* appears to be more common on the north-western peninsula than in other parts of the island. In North Iceland only a few characteristic plants occur. *Pleurogyne rotata* is, however, very common in North Iceland, but rather rare in other places; *Milium effusum* also is especially characteristic of the northern districts. *Phyllodoce coerulea*, which is so common in Greenland, is also fairly common on the northern mountainous peninsulas on either side of Eyjafjörður westwards as far as Fljót, but has not been found elsewhere; *Primula stricta* has been found only near Eyjafjörður, and *Antennaria alpina* and *Erigeron uniflorus* have been found only on mountains in North Iceland.

Moreover, it may be mentioned that, here and there, a few otherwise rather rare species, by occurring in great abundance in certain localities, give a characteristic appearance to the landscape. Thus, in Selvogur *Anthyllis vulneraria* occurs so abundantly that during the flowering period large tracts are quite yellow; in Eyjafjörður and in Hrappsey considerable areas are closely covered with *Viola tricolor*. In Trostansfjörður the whole strand is densely overgrown with *Cakile maritima*, which, although rather common in western Iceland, occurs nowhere so abundantly as here. An

unusually large quantity of *Viscaria alpina* grows at Ulfsvatn (400 metres above sea-level). An old lava-stream, south of Krakatindur and NE. of Hekla is almost exclusively overgrown with *Oxyria digyna*, which otherwise occurs rather rarely on lava. The neighbourhood of Eyjafjörður is characterized by a great abundance of *Gentiana*, and the neighbourhood of Lake Myvatn by its rich vegetation of *Nasturtium palustre* and *Pleurogyne rotata*; *Erysimum hieracifolium*, which is otherwise rather rare, occurs abundantly and as large specimens on the islands in Myvatn; *Succisa pratensis* is very numerous in Sida. A few rare plants have been found only in very far distant habitats, at opposite sides of the island, thus, *Ophioglossum vulgatum* at Gunnuhver at the extreme point of Reykjanes, and at Bjarnarflag near Myvatn. *Drosera rotundifolia* grows here and there near Breidifjörður and Faxafjörður and otherwise only in the extreme north between Eyjafjörður and Skagafjörður, *Cirsium arvense* occurs in a few localities which are as far apart as Grindavík and the Vestmannaeyjar towards the south, and Eyjafjörður towards the north.

In Iceland as in other arctic or subarctic countries with a coastal or insular climate there is comparatively but a slight difference in the vegetation of the lowlands and of the plateau, of the mountains and of the valleys; it is very difficult to arrange the species according to their altitudinal zone. Almost throughout the island, and everywhere where plant-life can thrive at all, plant-formations and plant-associations, with a few modifications, occur with a gradually increasing or decreasing luxuriance and number of species according to situation only. With the exception of the highest situated tracts, close to the snow-line, the distribution of the plants and the differences in the vegetation appear to be in a higher degree dependent on local climatic conditions, such as snow and other atmospheric precipitations, wind, conditions of soil, inclination, more or less sunny exposure, streams and springs rather than on the height above sea-level. A luxuriant vegetation with a lowland character often extends very far upwards on the mountains on the sunny side, or where a suitable degree of moisture and a protective snow-covering afford favourable conditions of life for the vegetation, while in the immediate neighbourhood, and often at a far lower level, cold sharp winds or sand-drifts have destroyed almost all plant-life and laid the land waste. Exceptionally favourable localities are afforded for plants in some places near hot springs

on the plateau. Some plant-formations such as birch-coppices and heather-moors, do not, however, extend to the highest levels, and many species disappear on approaching the snow-line; on the other hand, others, as mentioned above, are distributed in great abundance all over the island, from the sea-level to the snow-line.

The Icelandic climate affords good conditions of life for mosses, therefore Iceland has a luxuriant moss-vegetation which is not only shown in the great extent of the *Grimmia*-heaths, but proofs of it are seen in various other ways in nature. On the interior plateau in the most barren localities small green oases are often seen, consisting exclusively of mosses; on the abrupt faces of rocks they form bright green cushions around springs; and at the numerous waterfalls of Iceland there is a luxuriant moss-vegetation, rich in forms; blocks of rock and steep rock-faces are often covered with mosses, as also the numerous cracks in the lava-streams; and the damp rock-clefts are often rich in different species. Under various conditions of nature, various species of mosses are the dominant ones, and form various characteristic societies.

A considerable number of lowland species have an upper limit on mountains and plateau, but this has not as yet been thoroughly investigated. On the other hand, very few highland plants have a lower limit; the majority of the plants which grow near the snow-line thrive just as well in the neighbourhood of the sea. In many districts, and in some places on the northern peninsulas towards the North Atlantic, plant-associations with well-marked plateau-characters are seen in the vicinity of the sea; this is especially the case with associations of *Salix herbacea*, *Sibbaldia procumbens* and *Gnaphalium supinum*, which are otherwise peculiar to the plateaus. Of the commonly distributed species probably very few occur exclusively on the plateau; of such plants only *Ranunculus glacialis* is known; it grows in many localities near the snow-line and has doubtless only rarely been found below 300 metres. *Pedicularis flammea* has a similar distribution, but in some places it grows perhaps further downwards. Otherwise there are only a few rarer species which have been found only on mountains and plateau, but it is possible that on a closer investigation these may also be found at a lower level. Of these may be mentioned *Carex pedata*, *Poa laxa*, *Catabrosa algida*, *Sagina nivalis*, *Draba alpina*, *Ranunculus pygmaeus*, *Diapensia lapponica*, *Campanula uniflora*, *Antennaria alpina* and *Erigeron uniflorus*. Of common plateau-plants which also occur in

the lowlands may be mentioned, *Carex rostrata*, *C. lagopina*, *C. saxatilis*, *C. rigida*, *Eriophorum polystachyum*, *Luzula arcuata*, *Salix herbacea*, *Alsine biflora*, *Papaver nudicaule*, *Draba nivalis*, *Arabis alpina*, *A. petræa*, *Saxifraga caespitosa*, *S. oppositifolia*, *S. nivalis*, *Epilobium anagallidifolium*, *Gentiana nivalis*, *Sibbaldia procumbens*, *Gnaphalium Norvegicum*, *G. supinum*, and others. As already mentioned, many of the most common plateau-species are distributed on rocky flats throughout the country, both at high and at low levels; for instance, *Silene maritima* is as common along the coast as at the highest levels in the interior wastes, as also *Polygonum viviparum*, *Cerastium alpinum*, *Armeria maritima*, *Draba alpina*, *Oxyria digyna*, and several others. Therefore, speaking generally, it is not easy to distinguish the species of the rocky flats of the plateau from those of the lowland. The main difference consists especially in the more scattered growth of the individual plants and their partially stunted appearance on the plateau; moreover, in the lowlands several species are found intermixed with the above, often abundantly, which rarely appear on the plateau, for example, *Dryas octopetala*. Further, where the situation is favourable, very luxuriant patches may occur on the rocky flat of the plateau, at any rate in the centre of the island below 600—700 metres. As we have already seen, the altitude of the snow-line differs greatly in different districts, consequently, the characteristics of the plateau vegetation are met with at different altitudes in different parts of the island. In central Iceland the plateau-character often does not begin until at 600—800 metres, but on the northern peninsulas and headlands the plateau-vegetation often descends to an altitude of 300 metres, and in some places even lower. On the lower-lying parts of the plateau, especially in the neighbourhood of large glaciers, from which the melting snow and ice has not sufficient outlets, there are often found groups of lakes and extensive stretches of boggy and swampy land with a luxuriant vegetation of mosses and sedges. Such swampy tracts are found among other places on Tvidægri (450 metres), in the neighbourhood of Grimstungaheidi (500 metres), Miklumýrar near Hreppar (400—500 metres), Eyjabakkar near Snæfell (650 metres), Fljótsdalsheidi (400—500 metres), and several other places. The vegetation of these plateau-bogs is as yet very little known.

All the highest mountain summits and plateaus are covered with snow and ice, but along the edge of the plateau and in a few places upon the plateau itself there are several rather high mountain tops

which are snowless during summer. On these wind-blown rock-summits the plants generally encounter very unfavourable conditions, therefore many of the summits are quite bare of vegetation; on others a few lichen-crusts are seen on stones, or small *Grimmia*-cushions in clefts; and again on others a few scattered phanerogams are found. So far as is known, there are almost no notes regarding the plants on the mountain summits of Iceland, as the latter are rarely ascended by botanists, but geologists, on the other hand, are obliged to climb the mountains. I shall therefore take the opportunity here of inserting some fragmentary notes from my diary regarding the plants I found on the mountain-summits, with the heights measured. These notes were not intended for publication; I had put them down in my diary for my own information, but although they are fragmentary, they may be useful in showing that there is nothing specially characteristic in the vegetation of the mountain-summits. On the north-western peninsula: Kikafell near Brjámslækur (560 metres), *Grimmias*, *Salix herbacea*, *S. phylicifolia*, *Arabis petræa*, *Armeria maritima*, *Ranunculus glacialis*, *Silene acaulis*, all in flower July 22, 1886. Vattarfjall (401 metres), *Papaver nudicaule*, *Silene acaulis*, *Armeria maritima*. Bæjarfjall near Steingrímsfjörð (316 metres), *Silene acaulis*, *Armeria maritima*, *Cerastium alpinum*, *Polygonum viviparum*, *Empetrum nigrum*, *Saxifraga cæspitosa*. Drangaháls (315 metres), *Salix herbacea*, *Polygonum viviparum*, *Oxyria digyna*, *Rhodiola rosea*. Dalsheidi near Snæfjallaströnd (660 metres), mosses, *Silene acaulis*, *Salix herbacea*, *Gnaphalium supinum*, *Sibbaldia procumbens*. Klofningsheidi (606 metres), *Grimmias*, *Salix herbacea*, *Ranunculus glacialis*, *R. pygmæus*. Uxaskard near Látrar (Eyjafjörð) (518 metres), *Oxyria digyna*, *Salix herbacea*, *Armeria maritima*, *Ranunculus glacialis*. Hafursey near Myrdalsjökull (587 metres), *Grimmias*, *Salix herbacea*, *Silene acaulis*, *Polygonum viviparum*. Lodmundur (1097 metres), NE. of Hekla, *Grimmias*, lichens, *Salix herbacea*, *Silene acaulis*, *Cerastium alpinum*, *Saxifraga cæspitosa*, *Carex rigida*. Skálafell near Ölfus (578 metres), *Salix herbacea*, *Cassiope hypnoides*, *Armeria maritima*, *Arabis petræa*. On the plateau towards the west: Thristapafell near Eiríksjökull (714 metres), *Salix glauca*, *Armeria maritima*, *Cerastium alpinum*, *Silene acaulis*, *Salix herbacea*. Strútur (921 metres), on the summit no plants, but 130 metres further downwards, *Arabis alpina*, *A. petræa*, *Saxifraga hirculus*, *S. hypnoides*, *S. oppositifolia*, *Pedicularis flammea*. Botnssulur (1108 metres), only some lichens and *Grimmias* and *Salix herbacea* and

Empetrum nigrum — a miserable stunted specimen of each of these two species, 2 and 2½ cm. in height respectively. On the plateau towards the east: Kjarrdalsheidi near Lón (665 metres), *Salix herbacea*, *Polygonum viviparum*, *Oxyria digyna*, *Ranunculus glacialis*, all small and stunted. Markalda (961 metres) near the eastern edge of Vatnajökull, *Polygonum viviparum*, *Armeria maritima*, *Salix herbacea*, *Saxifraga nivalis*. Litla Snæfell (1133 metres), *Salix herbacea*, *Oxyria digyna*, *Arabis alpina*, *Ranunculus glacialis*. On Hlidarfjall near Myvatn (790 metres) where I was together with Grönlund in 1876, we noted the following plants: — *Alsine biflora*, *Draba nivalis*, *Saxifraga cernua*, *Cassiope hypnoides*, *Pedicularis flammea*, *Oxyria digyna*¹.

All that is situated outside the glacier-bearing mountains in the centre of Iceland at an altitude of 650—1100 metres may justly be regarded as a desert; seen both from a geological and geographical point of view the country here is desert-like in character, and in spite of considerable precipitation the plants suffer from drought, because the water disappears immediately over large areas owing to the porous nature of the rocky substratum — lava, tuff, volcanic gravel and sand. The few plants which grow in these wastes occur widely scattered; at a height of 900—1000 metres above sea-level a few lichens and mosses are seen only here and there, and at long intervals a few specimens of the hardy *Armeria maritima*, *Silene maritima* and *Polygonum viviparum* and in places where blown sand occurs a few tufts of *Elymus arenarius*; at a height of 1000—1100 metres one may ride for miles without coming across a single phanerogam. In addition to want of water, the frequent storms, often of sand and snow, check plant-growth during the short summer; moreover, a rather dry Föhn wind often blows across the wastes north of the great Jökulls, having already deposited its moisture upon the great plateaus of the Jökulls. Somewhat lower down, at an altitude of 700—900 metres, a few more species are met with as scattered individuals, e. g. *Silene acaulis*, *Arabis alpina* and *A. petraea*, and here and there a few haulms of *Luzula arcuata*, *Poa glauca* or *Festuca ovina*; moreover, a few scattered cushions or tufts of lichens (*Stereocaulon*) or mosses (*Grimmia*) occur.

Scattered here and there in these extensive wastes are sometimes

¹ See also Chr. Grönlund's list of plants from Heljardalsheidi and Hrafninnuhryggur, and the list of plants collected by Johnstrup on Dyngjufjöll (Karakteristik af Plantevæksten paa Island, 1884, pp. 28 and 29).

found, at intervals of a whole day's journey, some small oases with a denser vegetation, in places where water is present, especially springs which issue from under the edge of the lava-streams. I propose to give here the names of some of these oases and their height above sea-level, and add some notes on their vegetation, which is generally very little known. As almost no notes are published on the vegetation of the plateau I shall avail myself of this opportunity to give a list of the species I collected on some of these oases, as they have never been visited by botanists. Some of these plant-covered patches are only a few square metres in extent, and the largest of them are perhaps as much as a square km. in area¹. These oases often originate around hot springs, the temperature of which need not be very high — somewhat higher, however, than the mean temperature of the locality at which they rise. Thus NW. of Vatnajökull there are oases near Gæsavötn, 929 metres above sea-level, where the springs have a temperature of 5—7° C., and near Marteinsflæda (744 metres) with spring-temperature of 35½° C. and near Hitalaug (672 metres) with a temperature of 33½° C. Gæsavötn is the most highly situated of all the oases that I visited in 1884; plant-growth occurs here in connection with pools and springs; along the margins the vegetation is formed by mosses and *Salix herbacea* with scattered specimens of *Polygonum viviparum*, *Saxifraga stellaris*, *Oxyria digyna*, *Armeria maritima*, *Cerastium* and *Poa*, while *Carices* and *Eriophorum* form a fringe along the water's edge. Here I collected the following plants: — *Equisetum arvense* var. *alpestre*, *Calamagrostis stricta* var. *borealis*, *Aira alpina*, *Poa pratensis*, *P. pratensis* var. *alpigena*, *Poa alpina* var. *vivipara*, *Carex incurva*, *Eriophorum Scheuchzeri*, *E. angustifolium*, *Salix phylicifolia*, *S. herbacea*, *Polygonum viviparum*, *Oxyria digyna* f. *pygmæa*, *Armeria sibirica*, *Saxifraga stellaris* f. *pygmæa*, *S. decipiens* var. *grönländica*, *Ranunculus hyperboreus*, *Cerastium arcticum*, *C. trigynum*². From here I went to Hvannalindir near Kverkfjöll, the nearest oasis towards the east, but it took nevertheless two days (17, 18 Aug.) to reach it, travelling along the northern edge of Vatnajökull; along the whole of this stretch of land there were almost no plants, until at Jökulsá, 734 metres above sea-level, I found in the gravel a fairly large quantity of *Chamænerium latifolium* and *Oxyria digyna*.

¹ In my work "Island, Grundriss d. Geographie u. Geologie", 1906, there is a map showing the desert-boundaries and the oases known.

² Determined by Prof. Joh. Lange.

In Hvannalindir (656 metres) there occur along small streams a great many grasses and an abundance of tall specimens of *Archangelica officinalis*, but unfortunately I was prevented by a snow-storm from collecting plants there. At Vadalda at the springs of Svartá (674 metres) were found *Archangelica officinalis* and *Juncus balticus*. At Herdubreidarlindir (471 metres), north of the lofty mountain of Herdubreid, a rather rich vegetation occurs as a border along springs and branching streams while the surroundings consist of gravel quite bare of plant-life. Here I collected the following plants¹: — *Equisetum variegatum*, *Phleum alpinum*, *Calamagrostis stricta* var. *borealis*, *Festuca rubra* var. *hirsuta*, *Eriophorum Scheuchzeri*, *Juncus arcticus*, *J. triglumis*, *Luzula multiflora*, *Tofieldia borealis*, *Platanthera hyperborea* var. *major*, *Salix phylicifolia* var. *angustifolia*, *S. lanata*, *S. herbacea*, *Achillea millefolium*, *Erigeron uniflorus*, *Hieracium murorum*, *Galium verum* var. *aspera*, *Thymus serpyllum* var. *prostratus*, *Bartsia alpina*, *Pirola minor*, *Archangelica officinalis*, *Parnassia palustris*, *Cerastium vulgatum*, *Silene maritima*, *Epilobium alsinefolium*, *Chamænerium latifolium*, and *Alchimilla alpina*. On Odádahraun itself there are otherwise only extremely small plant-covered patches. In Hrótsrandir near Kollóttá Dyngja (653 metres), there occurred on a bottom of *Salix herbacea* a few small individuals of *Polygonum viviparum* and *Salix glauca* and far out on a neighbouring lava-stream a single specimen of *Taraxacum officinale* — the only one for miles round. Along some mountain-streams in the south-eastern corner of Dyngjufjöll small patches of a similar vegetation were found, only *Salix glauca* was far more vigorous here. Otherwise no continuous oases are found in the higher parts of Odádahraun, but only a few very widely separated desert plants, and in some places *Elymus arenarius* on blown sand. Towards Bárdardalur the vegetation increases gradually, and the sandy tracts, as far upwards as 500 metres above sea-level, are covered with *Elymus arenarius*, *Salix lanata* and *S. glauca*, and further downwards till about 450 metres, *Achillea millefolium* grows in abundance on the sand. In Miklimór between Sudurárbotnar and Alftakíll (about 450 metres) there is a considerable vegetation of different kinds of plants and even around Svartárvatn (409 metres) there is a rather rich vegetation like that on the sandy tracts of the lowlands.

On the north-eastern part of Vatnajökull east of Jökulsá and close to the glaciers, oases occur — separated by stretches of stony

¹ Determined by Prof. Joh. Lange.

deserts — which are as yet very little known, e. g. Thorláksmyrar, Mariutungur and Eyjabakkar (672 metres). I visited the last locality in 1894 and found there extensive areas covered with *Cyperaceæ*, cotton-grass and other plant-growth. In Fjallasveit, east of Jökulsá, a parish situated up on the plateau at an altitude of 400—500 metres, the population of which is solely dependent on sheep-rearing for their sustenance, very large tracts are covered with blown sand which in many places is densely overgrown with *Elymus arenarius*, *Salix lanata*, *S. glauca* and *Juncus balticus*, while *Carex incurva* grows abundantly on damp sandy flats. Near the farmstead Vidirhóll (415 metres) I collected in 1895 the following plants: — *Juncus balticus*, *J. triglumis*, *J. trifidus*, *Elyna Bellardi*, *Carex incurva*, *C. capitata*, *C. capillaris*, *C. vulgaris*, *C. rigida*, *C. rariflora*, *Poa pratensis*, *P. annua*, *Phleum alpinum*, *Festuca rubra* var. *arenaria*, *Calamagrostis stricta*, *Trisetum subspicatum*, *Selaginella spinulosa*, *Salix lanata*, *S. glauca*, *Saxifraga aizoides*, *Gentiana tenella*, *Pleurogyne rotata*.

North of Hofsjökull, at an altitude of 600—800 metres, similar barren wastes occur, as around Odáðahraun, consisting of ice-striated doleritic lava, and here also the individual plants occur widely separated, but, in the neighbourhood of stream and lakes, the oases are larger both in number and size. The vegetation of these oases is generally confined to small swamps and pools and sometimes to rather extensive mountain-bogs; in the pool-vegetation *Eriophorum* is usually dominant, but sometimes *Carices* are in the majority. In mountain bogs numerous large knolls (dys) often occur which are usually dry at the top and covered with mosses and various rocky-flat plants, but wet below and overgrown with swamp-plants. Dry tracts between the swamps are generally covered with *Grimmia*-heaths which sometimes pass into lichen-heaths. Of the oases occurring in these districts may be mentioned: Sydri Pollar, Nyrdri Pollar, Geldingáá and Laugafell (with hot springs), and southwards near Sprengisandur, on the eastern side there is Nyidalur, and on the western side Nauthagi and Arnarfell with an unusually luxuriant vegetation which has been described by St. Stefánsson¹, who also describes the plant-formations near Laugafell and Geldingáá. In Nydri Pollar (704 metres) I collected in 1896 the following plants: *Poa alpina*, *P. flexuosa*, *Carex rigida*, *Eriophorum angustifolium*, *Salix lanata*, *S. glauca*, *S. herbacea*, *Pedicularis flammea*, *Tofieldia*

¹ Geografisk Tidsskrift, XVI, 1902, pp. 230 and 231.

borealis, *Alsine biflora*, *Cerastium trigynum*, *Saxifraga Hirculus*¹. In Sydri Pollar (729 metres) I collected in the same year the following plants: — *Equisetum variegatum*, *E. arvense*, *Carex rigida*, *C. lagopina*, *C. rariflora*, *C. pulla*, *Juncus arcticus*, *J. biglumis*, *Eriophorum Scheuchzeri*, *E. angustifolium*, *Poa alpina*, *P. flexuosa*, *Phleum alpinum*, *Aira alpina*, *Festuca rubra* var. *arenaria*, *Calamagrostis stricta* f. *borealis*, *Salix glauca*, *S. lanata*, *S. herbacea*, *S. phylicifolia*, *Betula nana*, *Polygonum viviparum*, *Rumex acetosa*, *Arenaria ciliata*, *Cerastium alpinum*, *Silene acaulis*, *Cardamine pratensis*, *Tofieldia borealis*, *Montia rivularis*, *Thalictrum alpinum*, *Pinguicula vulgaris*, *Armeria maritima*, *Saxifraga decipiens*, *S. Hirculus*, *Pedicularis flammea*, *Eriogeron uniflorus*, *Thymus serpyllum* var. *prostrata*, *Veronica alpina*, *Dryas octopetala*, *Vaccinium uliginosum*, *Empetrum nigrum*, *Bartsia alpina*². As already mentioned, on Tvidæggra there are extensive stretches of bog-land and a considerable vegetation of various species. In 1898 I collected here, near Ulfsvatn (453 metres), the following plants: — *Juncus biglumis*, *J. triglumis*, *J. trifidus*, *Luzula spicata*, *Eriophorum angustifolium*, *E. Scheuchzeri*, *Carex alpina*, *C. atrata*, *C. dioeca*, *C. lagopina*, *C. pulla*, *C. rigida*, *C. sparsiflora*, *Aira caespitosa*, *A. flexuosa*, *Anthoxanthum odoratum*, *Festuca ovina*, *F. rubra*, *Phleum alpinum*, *Poa alpina*, *P. glauca*, *Trisetum subspicatum*, *Coeloglossum viride*, *Salix glauca*, *S. herbacea*, *Polygonum viviparum*, *Alsine verna*, *Cerastium alpinum*, *C. trigynum*, *Silene acaulis*, *Viscaria alpina*, *Ranunculus acer*, *Thalictrum alpinum*, *Cardamine pratensis*, *Draba incana*, *Geranium silvaticum*, *Saxifraga caespitosa*, *S. Hirculus*, *S. stellaris*, *Potentilla verna*, *Alchimilla vulgaris* f. *filicaulis*, *Sibbaldia probens*, *Vaccinium uliginosum*, *Bartsia alpina*, *Pinguicula vulgaris*, *Thymus serpyllum* var. *prostrata*, *Gentiana nivalis*, *G. tenella*, *Galium silvestre*, *Hieracium alpinum*, *Taraxacum laevigatum*. In the same year I collected near Hvalvatn (378 metres) the following species: — *Juncus triglumis*, *J. trifidus*, *Eriophorum angustifolium*, *Carex chordorrhiza*, *C. dioeca*, *C. Goodenoughii*, *C. lagopina*, *C. pulla*, *C. rariflora*, *C. rigida*, *Aira caespitosa*, *A. flexuosa*, *Anthoxanthum odoratum*, *Festuca ovina*, *Phleum alpinum*, *Poa glauca*, *Tofieldia borealis*, *Loiseleuria procumbens*.

South of the great Jökulls the vegetation generally extends further upwards on the plateau than to the north of them, but here also there are vast deserts of gravel, lava and blown sand, with a few widely separated oases, but it is especially the tracts between

¹ Determined by O. Gelert.

² Determined by O. Gelert.

Thjórsá, Skaftá and Mýrdalsjökull which are desert-like in character, and here there are also several bare tuff-ridges with numerous peaks. The sand is constantly drifting through the valleys and destroying all vegetation; only upon the highest ridges and peaks, which cannot be reached by the coarser grains of the drifting sand are seen several yellowish-green patches of mosses, and also along streams and around springs the moss-vegetation is sometimes fairly luxuriant and forms rather large green patches in places where very few or no phanerogams have been able to gain a foothold. Around Tjaldvatn (588 metres) in Veidivötn there is a considerable vegetation of different species; in 1889 I collected here the following plants: *Carex rigida*, *Poa pratensis*, *Festuca ovina*, *Salix glauca*, *Montia rivularis*, *Ranunculus acer*, *Batrachium paucistamineum*, *Thalictrum alpinum*, *Koenigia islandica*, *Empetrum nigrum*, *Rhodiola rosea*, *Parnassia palustris*, *Chamænerium latifolium*, *Hippuris vulgaris*, *Euphrasia latifolia*. Near Thorisvatn (591 metres) which is situated in the centre of large sandy deserts quite bare of vegetation, I found only *Salix glauca*, *Chamænerium latifolium* and *Carex rariflora*. On Blesamyri (535 metres) near Tindfjallajökull I found *Carex rigida* and *C. rariflora*. Near Hitalaug (650 metres) east of Torfajökull, in the neighbourhood of hot springs I found *Coeloglossum viride*, *Saxifraga stellaris*, *Sibbaldia procumbens*, *Pirola minor*, *Vaccinium uliginosum*, *Veronica alpina*, *Gnaphalium Norvegicum*, *G. supinum*, *Hieracium alpinum*. Near Hvannabotnar (434 metres) in the neighbourhood of Skaftá I collected: — *Equisetum palustre*, *Luzula campestris*, *Carex rigida*, *Calamagrostis stricta* f. *borealis*, *Anthoxanthum odoratum*, *Sibbaldia procumbens*, *Epilobium lactiflorum*, *E. Hornemanni*, *Gnaphalium Norvegicum*. Though the above list is naturally very incomplete owing to the author having had other work in hand (geographical survey and geological investigations) which left him no time for thorough botanical investigations or collections, yet these notes have been included here as these parts of the plateau are very difficult of access and are hardly ever visited by naturalists.

Outside the deserts in central Iceland, and nearer to the sea, there are also many, large and small, high-situated rocky areas and broken groups of rocks, pieces of plateau, and isolated peaks in the numerous mountain-spurs which extend between the branching valleys and fjords. The vegetation of these rocks is also very little known, but it resembles very much that of the plateau, only, it is usually richer in species. Highest up on the mountains, at an alti-

tude of 600—800 metres, there are usually gravelly tracts with scattered individuals of rocky-flat plants, such as *Silene acaulis*, *S. maritima*, *Cerastium alpinum*, *Luzula arcuata*, *Polygonum viviparum*, *Armeria maritima*, *Ranunculus glacialis*, *Saxifraga nivalis*, *S. oppositifolia* and others. In small damp hollows where the snow persists for a long time there is often a characteristic dense growth of *Salix herbacea*, which almost entirely conceals the moss-covering of the ground, together with *Sibbaldia procumbens*, *Gnaphalium supinum*, *Oxyria digyna* and *Polygonum viviparum*; in some places these are associated with several other plants. In other places there are small patches of *Grimmia*-heaths with scattered specimens of *Pedicularis flammea* or *Cassiope hypnoides*. Here and there streams and bogs occur with *Carex rigida*, *C. lagopina*, *C. rostrata*, *C. incurva* and others, but most often with *Eriophorum angustifolium* and *E. Scheuchzeri*.

As has been seen from the preceding notes on the vegetation of the plateau it is not easy to determine the altitudes or upper limits of the different plant-regions. Of the Scandinavian upper zones, the region of conifers is entirely absent, but, on the other hand, we may be justified in speaking of a birch-region, of an osier-willow region, and perhaps a lichen- or moss-region, but these regions pass into one another in many ways, and overlap. During the period after the Ice Age (the *Purpura-lapillus* Period) when it was warmer than it is now, the birch grew everywhere in the lowlands even on the northernmost headlands, but it had already retired from the latter at the time the first settlers came to the island, and since then, as we have already seen, its distribution has been considerably limited owing to the interference of man and sheep. The present Polar limit of *Betula odorata* in Iceland has not been fully investigated, but judging from what I saw on my journeys it appears, on the east coast, to extend across Vopnafjörður to the west coast of Melrakkasljetta, across Axarfjörður and Skjálfandi to Eyjafjörður near the mouth of the valley of Fnjóskadalur. The stretch of land between Eyjafjörður and Hunaflói is now devoid of birch coppices, although these occurred there in olden times; how far out they extended at that time upon the peninsulas between the fjords is not known. From Hunaflói the northern limit of the birch extends from Steingrímsfjörður to Ísafjardardjúp. This is, however, only quite a provisional limit; the subject requires to be investigated more closely. As regards the upper limit of the birch, it differs considerably in different parts of the island; it extends highest in Thingeyjarsýsla

— near Myvatn to 550 metres. Birch coppices occur on the mountains of Vindbelgur (540 metres) and Dalfjall (550 metres). In olden times there were in Króksdalur and Yxnadalur — a continuation of Bárdardalur — considerable woods up to 450 metres. On the south coast the birch coppices do not as a rule extend so far upwards on the mountains; in Kollumuli near Lón birch coppices oc-



Fig. 27. Woods in Hallormstad; June 1909.
(Phot. A. Hesselbo.)

cur, however, at a height of about 500 metres, but, nowhere else along the south coast did I find birch coppices at that altitude. The forest of Nupsstadaskogur, south of Vatnajökull, reaches to an altitude of 400 metres, Bæjarstadaskógur in Øræfi to 320 metres, and coppices in Haukadalsheidi to 380 metres, but in the southern lowlands the limit for birch coppices usually occurs at a height of 200—300 metres; in some places at a slightly higher, in others at a slightly lower level. According to the Ordnance map the upper limits of the coppice-woods in South Iceland are as follows: —

Skátafell in Øræfi	280 metres
Jökulfell (Bæjarstadaskogur).....	320 —
Nupsstadaskogur	400 —
Thorsmörk	320 —

Markhlidar	250 metres
Burfell near Thjórsárdal.....	300 —
Skridufellsskogur.....	220 —
Tungufellsskogur....	260 —
Haukadalshéidi	380 —
Uthlidarhraun	320 —
Laugardalsskogur	280 —
Thingvallaskogar.....	200 —
Botnsskogur	200 —
Skorradalur	150 —
Svinadalur	200 —
Husafellsskogur.....	260 —
Hvítársíða.....	300 —

Although it is possible that birch coppices may be met with in some places at a somewhat higher level yet the limits will be approximately those given above. On the north-western peninsula, birch coppices occur mostly on the southern side at the head of the valleys and fjords which extend upwards from Breidifjörður and face the sun; but the birch coppices extend hardly anywhere higher than 200—300 metres, and usually occur at far lower levels. There is also a good deal of birch coppice at the branch-fjords of Arnarfjord, in Dyrafjord and at the southern fjords of Isafjardardjup, especially at Hestfjörður. North of Isafjardardjup I nowhere saw birch coppices proper, although a few individuals of *Betula odorata* occur in some places in Adalvík; nor are birch coppices known to occur on the east coast from Cape Nord to Steingrímsfjord.

To the birch region belongs also *Sorbus aucuparia* which occurs as scattered individuals both in the birch coppices and outside them; I do not think the mountain ash extends so far up as does the birch; I did not observe it at higher altitudes than on Sluttnes in Myvatn, 290 metres above sea-level. *Betula nana* occurs now and then in birch woods, but grows most commonly on heather moors and in bog-lands; it rarely forms coppices proper. It extends higher on the mountains than *Betula odorata*; I found it, for instance, in Sydri Pollar, 729 metres above sea-level. *Juniperus communis* is fairly common in birch coppices and on heather moors; the highest altitude at which I found it was in Yxnadalur near Odádahraun, 488 metres above sea-level. The heather moor is closely associated

with the birch region, and it probably rarely extends higher than 300—400 metres above sea-level as an aggregate plant-formation; but several of the different species of which the heather-moor is composed extend far higher up on the mountains without forming any heath-like associations, occurring as a few individuals only. I found *Vaccinium uliginosum* at the highest level (729 metres) near Sydri Pollar, and also *Dryas octopetala* at the same place; *Empetrum nigrum* extends to a similar height, and I came across a stunted specimen even on the top of Botnssulur at an altitude of 1108 metres. *Cassiope hypnoides* extends to a great height also; it is found, among other places, on Hlidarfjall at 790 metres above sea-level, and may perhaps extend even higher. *Loiseleuria procumbens*, on the other hand, did not occur at a higher level than 400—500 metres. *Calluna vulgaris*, *Arctostaphylus uva ursi* and *Vaccinium Myrtillus* were found near Myvatn at an altitude of about 400 metres, but I do not think they extend higher than the limits of the heather moor.

Above the upper limit of the birch region an osier or a willow region may be said to occur — in the centre of the country at an altitude of 500—800 metres, in other places somewhat lower — where willows are dominant among the woody plants, although they have their greatest distribution at a far lower level, in the birch region itself. At this altitude they do not form any coppice proper, but occur as flat expanses of low prostrate shrubs. Above the birch region it is especially *Salix herbacea*, *S. lanata* and *S. glauca* which are the dominants; *Salix phylicifolia* retires, although small specimens of the latter also are now and then met with even at this altitude. *Salix lanata*, and to some extent *S. glauca*, occupy large areas of the lower parts of the plateau, e. g. in Fjallasveit, Myvatn-söræfi, Sudurárbotnar, and several other places; they are of great importance to sheep-breeding, and in some places quantities of willow leaves are gathered as winter-fodder for sheep and cattle; in the lowest part of this zone *Betula nana* occurs now and then. In the centre of the country above 800—900 metres and up to the snow-line at an altitude of 1000—1400 metres, mosses and lichens are undoubtedly the dominant plants, although a few widely scattered phanerogams also occur. *Salix herbacea* extends also through this region to the snow-line; here and there, the most hardy of the previously mentioned rocky-flat plants occur as somewhat scattered individuals, but the main vegetation consists of mosses, although these do not occur in any great abundance compared with the vast

areas. Mosses often form an edging or fringe around loose stones on gravelly flats or also cushions on heaps of stones or in rock-crevices. On the highest situated and most inhospitable rocky and gravelly tracts, where storms are constantly driving sand and gravel across the surface, not even mosses can thrive, and the ground is quite bare. A few species of lichens (*Cladonia* and *Cetraria*) are sometimes found in the moss cushions, but usually they occur only as crusts on blocks of rock. Here and there on clayey soil in depressions crusts of liverworts occur, especially *Anthelia nivalis*, often associated with *Grimmia hypnoides* and *Salix herbacea*; round pools and along streams, cushions of bright green mosses are often seen, in which some flowering plants have sometimes found a home. In other parts of the country, the three regions mentioned here occur at a lower level, since they are correlated with the altitude of the snow-line in the different parts of the country.

V. A SKETCH OF THE CHIEF PLANT-FORMATIONS OF ICELAND.

WE will now give a brief account of the commonest and, from a geographical point of view, most important plant-formations of the land-vegetation of Iceland, without, however, entering into details or into local deviations of the different plant-associations. This account is based partly on my own observations and partly on those published by others; I have especially made use of Dr. Helgi Jónsson's numerous excellent descriptions of the vegetation-forms of Iceland. Here I shall confine myself to the purely geographical distribution without entering more closely into relations of causation, or into questions of general ecology, which will no doubt be exhaustively discussed later on. The division into plant-formations and -associations is as yet, in many respects, dependent upon individual opinion. In the following, with the exception of a few deviations, I am adopting Dr. H. Jónsson's main divisions. Dr. Jónsson is the most experienced investigator of the vegetation of Iceland, and has described the plant-life from many more parts of Iceland than has anyone else. But much work remains to be done by future investigators; the vegetation-conditions from more than one-half the total area of the island are still to be described, and so many local variations, and such varied associations occur within the larger formations that it will be a long time before the details from everywhere are well-known. The following is only a brief account for the general orientation of the larger plant-formations and of the chief points regarding the distribution of the higher plants according to present knowledge¹.

¹ Besides the above-mentioned works on the flora of Iceland, there are the following descriptions of the vegetation: — Chr. Grönlund: *Karakteristik af Plantevæxten paa Island, sammenlignet med Floraen i flere andre Lande* (Naturhistorisk Forenings Festskrift, 1890 [printed 1884], pp. 107—145). C. H. Ostenfeld: *Skildringer af Vegetationen paa Island* (Botanisk Tidsskrift. XXII, 1899, pp. 227—

The Vegetation of the Coast-line. The halophilous plant-associations along the greatly extended coast-line of Iceland have, as in other places, a rather heterogeneous soil consisting of fine and coarse strand sand, large pebbles or boulders, blown sand and rocks of basalt and tuff. Very generally round the coast there is seen upon low rocks¹, at the foot, a belt of *Verrucaria maura*; then come grey, yellow and green patches of several kinds of lichens; above this level only a few plants occur, mostly scattered individuals of *Cochlearia officinalis*, *Plantago maritima*, *Armeria maritima* and *Glyceria distans*. On steep, lofty coast-cliffs *Cochlearia officinalis* and *Rhodiola rosea* often occur in great abundance, also *Silene maritima*, *Armeria maritima*, *Cerastium alpinum* and various species of *Poa* and *Festuca*; to these should be added *Haloscias scoticum* in south-western Iceland and especially on the islands in Breidifjörður. As is well-known, there are several large sea-fowl cliffs along the coast of Iceland, but their vegetation has not yet been investigated; H. Jónsson has investigated only a few smaller sea-fowl cliffs in Dalasýssel and "sea-fowl-grass-slopes" (Fuglegræslier) in Skaftafellssýssel. According to H. Jónsson (1905, p. 37) the grass-covered mountain-slopes in South Iceland frequented by sea-fowl differ from the common grass-slopes, among other things in the abundant occurrence of *Poa pratensis* and *Stellaria media*; the occurrence of *Festuca elatior* and *Avena elatior* on "sea-fowl-grass-slopes" is also characteristic of the latter. The vegetation of the lofty sea-fowl cliffs appears principally to consist of the same plants as are found on common coast-cliffs, for instance, *Cochlearia*, *Rhodiola*, *Archangelica*, as also *Oxyria* and *Stellaria*; all growing luxuriantly. Owing to the soil being manured there is an immigration of many other species, especially from the grass-slope and the grassland; these species grow as luxuriantly in rock crevices and on ledges as in the most well-manured home-fields. Collections of plants from these sea-fowl cliffs have never been made; the plants being extremely difficult of access.

253; XXVII, 1905, pp. 111—122). Th. Thoroddsen: Planteverdenen paa Island (Salmonsens Leksikon, IX, 1899, pp. 606—607). Helgi Jónsson: Studier over Ost-Islands Vegetation (Bot. Tidsskr., XX, pp. 77—89). Vegetationen paa Snæfellsnes (Vidensk. Medd. fra naturh. Foren. i København, 1900, pp. 15—97). Vegetationen i Syd-Island (Bot. Tidsskr., XXVII, 1905, pp. 1—82). Vegetationen paa Island (Atlanten, 1904, pp. 41—50). Gróðrar- og Jarðvegsrannsóknir (Búnaðarrit XX, 1906, pp. 146—181; XXIII, 1909, pp. 41—54). Fyrirlestur um gróður Islands (Búnaðarrit, XXI, 1907, pp. 6—20). Bygging og líf plantna, København, 1907, pp. 289—300.

¹ Cf. Eug. Warming: Dansk Plantevækst, I, København, 1906.

On the strand sand, especially in South Iceland, there is a fairly characteristic vegetation of *Halianthus peploides*, *Cakile maritima*, *Atriplex patula*, *Stenhammaria maritima* and *Potentilla anserina*; often, each of these species occurs separately and in abundance, but sometimes they are found intermixed in various ways. *Cakile maritima* usually occurs nearest to the sea, and *Potentilla anserina* at the highest levels, occupying large areas, and occurring so abundantly that the ground is quite interwoven by its creeping shoots. On the strand sand are also seen in small numbers *Cochlearia officinalis*, *Matricaria inodora*, *Silene maritima*, *Polygonum aviculare*, *Stellaria crassifolia*, *S. media*, *Capsella bursa pastoris*, *Glyceria distans*, *Festuca rubra*, *Elymus arenarius*, *Carex incurva*, etc. On the vast sandy stretches along the south coast blown-sand formations are frequent nearest to the sea; here *Halianthus peploides* and *Elymus arenarius* occur in tufts; above this belt of sand dunes, tracts are found occupied by a vegetation richer in species and consisting of *Potentilla anserina*, *Festuca rubra* var. *arenaria*, *Thymus serpyllum*, *Galium verum*, *Achillea millefolium*, *Juncus bulbosus*, and several others. But below the glacier-bearing mountains (Jökulls) the strand sand quickly merges into glacier sand, which forms sandy wastes extremely poor in plant-life.

At several places along the coast of Iceland salt-marshes are found, overflowed by salt water, for example in Borgarfjörður, Myrar, Hornafjörður and Lón. In Myrar the dominant species are *Glyceria maritima*, *Agrostis alba*, *Plantago maritima*, *Stellaria crassifolia*, moreover *Heleocharis uniglumis*, *Triglochin maritima*, *Juncus bufonius*, several species of *Carex*, etc. H. Jónsson found that in some places two-thirds of the area was occupied by *Glyceria maritima* and one-third by *Agrostis alba*, each species occurred separately in patches; some thick-leaved *Plantago maritima* occurred, however, in the *Glyceria* patches¹.

The Vegetation of the Fresh Water. Plant-life occurs very sparingly in running water, and where strong currents are felt it is usually absent. Nor do plants appear to thrive in glacier-rivers; this is probably due to the low temperature of the water and the current. In slowly flowing river-arms on level land, in rivulets and brooks there is often a considerable quantity of green algae (*Zygnema* and *Spirogyra*), both at the bottom and upon the surface; in South Iceland *Enteromorpha intestinalis* is common in streams. The fol-

¹ Bunadarrit, XX, 1906, pp. 150, 151.

lowing mosses are found on stones in rivulets and brooks: *Fontinalis antipyretica* very frequently, also *F. gracilis* and *F. thulensis*, *Amblystegium Kneiffii*, *A. ochraceum*, *Hypnum rusciforme* var. *atlantica*, and others¹. The vegetation of lakes and pools is much richer and differs considerably according to the depth of the water and the nature of the bottom, etc. The plankton of the Icelandic lakes has as yet been very little investigated; there are only a few notes to hand from Myvatn and Thingvallavatn. In Myvatn zooplankton only was found; Thingvallavatn contained phytoplankton in which diatoms were dominant². In deep lakes there is usually very little or no vegetation at greater depths, only in places where it is shallower does plant-life occur. In Thingvallavatn, however, there are large areas covered with *Chara* and *Nitella*, especially at a depth of 13—30 metres, and they extend even down to 38 metres³. Where the lakes are shallower various species of *Potamogeton* and *Myriophyllum* and also *Batrachium paucistamineum* are common. Near the margin and in smaller pools the most common, and usually dominant, species are the following: *Heleocharis palustris*, *Equisetum limosum*, *Carex rostrata*, *Menyanthes trifoliata*, and in the southern lowlands *Glyceria fluitans* is common; to these should be added *Hippuris vulgaris*, *Eriophorum angustifolium*, *Sparganium minimum*, *S. submuticum*, *Ranunculus hyperboreus* and *R. reptans*, *Subularia aquatica*, *Callitriche hamulata* and *C. verna*, *Limosella aquatica* and several others, the occurrence of which varies somewhat according to the quantity of the water, the conditions at the bottom, etc. Where *Equisetum limosum* occurs in abundance it is cut annually and used for fodder for milch cows. In Myvatn and in other lakes in Thingeyjarsýsla *Nostoc*-lumps are found in abundance, often thrown up on the shore in very great quantities. Sometimes in warm summers large areas of Myvatn become turbid; this phenomenon is known by the inhabitants as "leirlos" — it is said to be very injurious to salmon-trout, their gills becoming filled with the fine particles — when this occurs they retreat in great numbers to the eastern shore of the lake, where the water is purer and clearer owing to the numerous springs which here issue from the lava⁴.

¹ H. Jónsson, 1900, p. 17, 1905, p. 7.

² C. H. Ostenfeld and C. Wesenberg-Lund: A Regular Fortnightly Exploration of the Plankton of the two Icelandic Lakes, Thingvallavatn and Myvatn. (Proc. R. Society Edinburgh, Vol. 25, Part 12, 1906, pp. 1092—1167).

³ B. Sæmundsson in Andvari, 1904, p. 89.

⁴ Dr. H. Jónsson informs me that the so-called "leirlos" is probably due to Blue-green Algæ perhaps *Aphanizomenon flos aquæ*.

Springs (kaldaværmsl, dy¹) are very common in Iceland, and are found in almost every valley below the mountain-sides or appear in rows upon the ledges of the basalt-layers. The peculiar vegetation connected with these streams is widely distributed below the mountain-sides and often occurs in the midst of other formations or high up on the mountain-sides in narrow zones in places where other vegetation is wanting. This vegetation is characterized especially by the fresh bright-green colour of the mosses; *Philonotis fontana* is everywhere the dominant plant, but many other species of moss also occur, especially *Pohlia albicans* var. *glacialis*, and various species of *Bryum*, *Amblystegium*, and several other genera. Several phanerogams occur among the mosses, the most common are *Epilobium alsinifolium*, *E. Hornemanni*, *Cerastium trigynum*, *Montia rivularis*, *Saxifraga stellaris*, and *Catabrosa aquatica*, sometimes associated with *Ranunculus hyperboreus* and *Caltha palustris*, *Marchantia polymorpha*, etc. As this spring-vegetation usually occurs close to bogs and swampy tracts, there are often transitions to bog- and swamp-vegetation.

Vegetation around Hot Springs. Peculiar to Iceland is the characteristic vegetation near hot springs. The heat of the soil and the hot water create exceptionally favourable conditions for plant-life, so that species which otherwise do not grow in Iceland can thrive here, and species from South Iceland which do not otherwise grow in North Iceland also occur here near hot springs. It is to be regretted that the vegetation connected with these springs has been more closely investigated in a few places only². It is especially the rich algal flora, which for instance is of great importance as regards the separation of silica from the hot water, which requires investigation. The vegetation around the hot alkaline springs is usually very luxuriant and may extend over fairly large areas, because the aqueous vapour floats above the surroundings and descends as a continuous, drizzling rain of tepid water. The plant-associations may differ somewhat according to local conditions, as to whether the surroundings are damp or dry, gravelly or rich in humus. Where the surroundings of the springs consists of a hard grass-bottom, the following

¹ In Iceland the word "dy" is also applied to small pools in swampy tracts.

² Plant-life near the hot springs has been investigated especially by C. Ostenfeld, Bot. Tidsskr., vol. 22, 1899, pp. 299—245; by Chr. Grönlund: Karakteristik af Plantevæksten paa Island, pp. 33—35 and by Japetus Steenstrup and F. M. Liebmann, Forhandl. v. d. skandin. Naturforskeres 2. Møde 1840, København, 1841, pp. 336—340.

plants are common: *Potentilla anserina*, *Leontodon autumnalis*, *Trifolium repens*, *Brunella vulgaris*, *Gnaphalium uliginosum* and *G. silvaticum*, *Hydrocotyle vulgaris*, *Ranunculus acer*, *Sagina procumbens*, *Spergula arvensis*, *Plantago major*, *P. maritima* f. *pygmæa*, *Polygonum persicaria*, *P. aviculare* and various Gramineæ, and sometimes *Vicia cracca*. Where it is damper occur *Epilobium palustre*, *E. alsinifolium*, *Cardamine multicaulis*, *Montia rivularis*, *Limosella aquatica*, *Juncus lamprocarpus*, *J. bufonius* and some *Carices*. The composition of these groups of species differs however considerably at the different kinds of springs. Of vascular plants the following have been observed exclusively near alkaline hot springs: *Hydrocotyle vulgare*, *Gnaphalium uliginosum*, *Veronica anagallis*, *Polygonum persicaria*; rare outside the range of influence of hot springs are *Galeopsis tetrahit*, *Plantago lanceolata*, *P. major* and *Blechnum spicant*. Moreover, C. Ostenfeld enumerates eight species of mosses which have been found only on warm soil, and three species which are especially connected with a warm ground. In North Iceland some species grow only near hot springs, which in South Iceland thrive also outside the area of the warm soil, for instance, *Brunella vulgaris*, *Plantago lanceolata*, *Cardamine multicaulis* and *Drosera rotundifolia*. In the outlets from both the warm and hot springs an abundance of algæ often occurs — often in a great heat — which have not as yet been investigated. Near solfataras vegetation is extremely sparse, and in the immediate neighbourhood of the sulphurous-acid fumaroles no plant-life can thrive, therefore only bare clayey flats occur there. *Ophioglossum vulgatum* grows only near solfataras; in 1882 I found at Bjarnarflag near Myvatn scattered, but numerous, specimens of it on clayey ground which had a temperature of 27° C. — it occurred together with *Sagina procumbens* and *Poa pratensis*; and in 1883 I found it near Gunnhver on Reykjanes also on warm clay in the neighbourhood of sulphur springs. In both localities it occurred together with the otherwise rare *Riccia bifurca* and *Chomocarpon commutatus*. C. Ostenfeld found it on Reykjanes in the neighbourhood of steaming holes, "first a crust was found held together by a *Stigonema*-species, then a great many Muscineæ of which the most characteristic were *Riccia bifurca* and *Chomocarpon commutatus*. Amongst them occurred some other mosses: *Pohlia nutans* v. *filicaulis*, *Fossombronina Dumortieri*, *Bryum ventricosum*, *Fissidens osmundioides* and *Philonotis fontana*, moreover, the characteristic *Ophioglossum vulgatum* var. *polyphylla*" (loc. cit. p. 240).

Ostenfeld also describes the vegetation near the boiling mud-pools, and writes: "Close to the mud-pools the ground is quite bare, and not until some distance from them do plants begin to appear; nearest to them occurred *Agrostis alba* forming a net-work with its long rhizomes, and beyond this came a dense, low carpet of *Sagina procumbens*, *Cerastium vulgatum*, *Plantago major* (dwarf-form), *Stellaria media* and a great abundance of *Grimmia hypnoides*; somewhat further off many other plants occurred." "The vegetation near the outlet of the large mud-pool Gunna was characteristic and peculiar; here the damp ground (about 30° C.) was covered by a pure, green carpet of *Nardia crenulata* in which only one other plant occurred, viz. *Juncus bufonius*; within there was firm soil the particles of which were held together by moss-protonema. The moss-carpet became brownish-red where the ground was drier, but it was only *Nardia* which changed colour; some mosses occurred, however, along the outer edge, but only as a subordinate component" (loc. cit. pp. 239, 240). Near numerous solfataras in the neighbourhood of Myvatn, on Odáðahraun, Kerlingarfjöll, Torfajökull, and in several other places no vestige of plant-life occurs.

Vegetation on Wet Soil (bogs, pools, swamps and wet meadows). Bog- and swamp-land (myrar) is very extensively distributed in Iceland, both on the plateau and in the lowlands and valleys; these tracts are also of great economic importance, as in the inhabited districts the grass is cut for hay, and the hay (úthey) is used as winter-fodder for sheep and ponies. In Iceland the swampy meadow-tracts are divided according to their water-content into two main divisions, myri (pl. myrar) and flói (pl. flóar); the soil of the former is firm and tough owing to the interwoven roots and rhizomes; in the latter the soil is rotten, and more loosely connected, so that cattle thrust their legs through it and easily get stuck fast: in the former the surface is saturated with the ground water, but in the latter the water reaches to the surface or slightly above it, consequently here pools of all sizes abound. Upon the flat surface of the "myrar" small cone-shaped knolls usually occur, and in "flóar" water-channels and swampy holes are often found between the knolls. The vegetation is far denser and more continuous in the former than in the latter. The dominant species in the swampy "flói" are *Carex chordorrhiza*, *Eriophorum angustifolium* and *Scirpus cæspitosus*, and frequently occurring species are *Carex rostrata*, *C. saxatilis*, *C. Goodenoughii*, *C. limosa*, *C. rariflora* and several other *Carices*, as also

Menyanthes trifoliata, *Equisetum limosum*, *Heleocharis palustris*, etc. Upon the knolls, which are dry, many other plants occur, often *Betula nana*, *Vaccinium uliginosum*, *Salix glauca*, etc. The ground-vegetation consists of several species of mosses, *Amblystegium*, *Sphagnum*, *Hylocomium*, and others. On the mountains *Eriophorum*-bogs are very frequent and *Carex*-bogs of rarer occurrence, but in the lowlands the reverse is the case. Moss bogs with different aquatic



Fig. 28. Geitabergsvatn. Flooded meadow with *Eriophorum* and *Carex*.
(Phot. A. Hesselbo.)

vegetation, as at the above-mentioned springs, often occur in these swampy tracts, and pools with *Equisetum limosum*, *Hippuris vulgaris*, *Menyanthes* and *Sparganium*. The Icelandic "myrar" are richer in species and have a denser vegetation than the "flóar." The dominant plants are *Carex cryptocarpa* and *C. Goodenoughii*, but in addition many other species of *Carex* occur, viz. *C. rariflora*, *C. canescens*, *C. microglochin* and others, moreover, *Eriophorum Scheuchzeri*, *Equisetum palustre*, *Comarum palustre*, which are characteristic of wet meadows, *Caltha palustris*, *Parnassia palustris*, *Cardamine pratensis*, etc. Almost everywhere the above-mentioned genera and many others are associated with a moss-bottom. Sometimes some *Gramineæ*, *Polygonum viviparum*, *Euphrasia officinalis*, etc. occur upon the knolls, and in south-west Iceland, here and there on moss-covered knolls, *Drosera rotundifolia*. From the outer edge of the

water-saturated tracts, where the ground is becoming drier, are easy transitions to other plant-formations, such as grassland, heather-moor, etc.

Rocky flats. Of all plant-formations, the rocky-flat-formation occupies the largest area in Iceland, and is the one which characterizes by far the greatest part of the island. In favourably situated localities nearest the coast it passes into a "herb-flat" (Urtemark) with



Fig. 29. Lake near Armuli, with *Carex rostrata*.
(Phot. A. Hesselbo.)

a dense vegetation of different plants, and with some mosses and lichens; but usually the plants are too scattered to have any influence worth mentioning upon the appearance of the landscape. The vegetation of the rocky flat, which includes a great proportion of all the plant-species of the island, may be divided into many sections according to soil-conditions. On climbing higher up on the plateau we find that species and individuals become fewer in number and more scattered in growth, and as already stated, in the highest parts of the plateau only a few stunted, widely separated plants occur. On rocky flats situated at high levels mosses play an important part, especially *Grimmia hypnoides*, which gradually forms soil for higher plants; now and then some fruticose lichens are found intermixed with the mosses, and in many places on the

plateau patches of *Anthelia nivalis* occur. The rocky-flat-formation appears to be an original, late Glacial formation from which a great many distinct formations have developed, the different species having become associated according to their conditions of life. The outer limits of the rocky flat are the *Grimmia*-heath and the "herb-flat," but transitional stages to heather-moor and grassland often occur. As sub-divisions or nearly related formations the following may be mentioned: — gravelly flats (melar), stone-covered ridges (holt); fallen blocks and debris upon mountain slopes (urd, pl. urdir), steep cliffs (hamrar), gravelly river-plains and river-terraces (eyrar), sandy tracts of various kinds, clayey flats and lava-streams.

Gravelly flats (melar) also occupy large areas in the lowlands: the soil-conditions differ somewhat, but generally the gravel is mixed with clay and then the surface often cracks into polygonal cakes and forms a "rudemark" (p. 257). These "rudemarks" greatly influence plant-distribution, as the plants generally resort to the gravel bands between the cakes, where they find shelter and protection. Sometimes gravelly flats are so poor in plant-life that they appear quite bare and naked; sometimes they are so densely covered as almost to form a "herb-flat." The most common plants on gravelly flats in the lowlands are *Cerastium alpinum*, *Arabis petraea*, *Draba hirta*, *Silene acaulis*, *S. maritima*, *Armeria maritima*, *Salix herbacea*, *Sagina nodosa*, *Spergula arvensis*, *Arenaria ciliata*, *Alsine verna*, *Thymus serpyllum*, *Dryas octopetala*, *Papaver nudicaule*, *Oxyria digyna*, *Rumex acetosella*, *Trisetum subspicatum*, *Poa glauca*, *Festuca ovina*, *Agrostis alba*, *Luzula multiflora*, *L. spicata*, etc. Naturally all the above-mentioned species do not occur together; in some places a great many of them may occur, while in other places a very few, perhaps only three or four, may be found. The vegetation is also somewhat dependent upon neighbouring plant-formations. Usually mosses or lichens are very sparsely present upon these gravelly flats in the lowlands; only here and there small *Grimmia*-cushions occur.

On stone-covered ridges (holt) there is usually a greater variety as regards soil and situation than on the gravelly flats, and the vegetation there is sometimes fairly luxuriant and conspicuous especially in early summer when *Silene acaulis*, *Dryas octopetala* and *Thymus serpyllum* are in bloom; these are very common there, and also the majority of the plants of gravelly flats. Moreover, the following are noteworthy: *Alchimilla alpina*, *Saxifraga cæspitosa* and *S. oppositifolia*, *Viscaria alpina*, *Empetrum nigrum*, *Sedum acre*

and *S. annuum*. As the environment of the ridges differs greatly — sometimes bogs, sometimes dry grassland, sometimes heather — the vegetation on the ridges also differs somewhat in the different districts owing to immigration from these plant-associations. Mosses



Fig. 30. *Dryas octopetala* (Vallanes; June 26, 1909).
(Phot. A. Hesselbo.)

are few in number, but there is often an abundance of crustaceous lichens, chiefly various species of *Lecideas* and *Lecanoras*, which often impart a strongly variegated appearance to the rocky boulders.

River gravel has one characteristic plant all throughout Iceland, viz. *Chamænerium latifolium*, the splendid, purple flowers of which occur in large patches upon gravel-tongues between branching rivers, and can be seen from a distance. Besides plants common to gravelly flats several willows often occur here, viz. *Salix glauca*, *S. lanata* and *S. phylicifolia*, and also *Saxifragaceæ*, *Galium verum*, *G. silvestris*, and others. Clayey flats with a denser vegetation and a soil rich in humus frequently occur at the outer edges of gravelly

flats; they have a characteristic vegetation consisting of *Koenigia islandica*, *Sedum villosum*, *Juncus alpinus*, *J. biglumis* and *J. triglumis*; moreover, *Epilobium palustre*, *Spergula arvensis*, *Sagina procumbens*, *S. nodosa*, *Stellaria crassifolia*, *Polygonum aviculare*, *Equisetum palustre*, *Triglochin palustris*, *Agrostis alba*, *Luzula spicata* and some other species occur frequently, which are distributed according to the water content, etc. of the clayey flats.

The vegetation of mountain-slopes is often only an extension of that of the rocky flats, with the difference that greater variations occur at the base of the mountains, the conditions there being more highly diversified: the stony tracts alternating with bogs, springs, grass-slopes, heather-moors, coppice-woods, etc. But frequently mountain slopes consists mainly of downward-gliding gravel-masses or angular rock-fragments, with little or no vegetation, the stone-covering being too unstable to permit plants to gain foothold; in other places are heaps of loose blocks of rock (urds) or solid rock-terraces or -faces; in many places mountain-streams excavate channels or deep ravines, and at the base of mountains they cause the formation of broad gravel-cones with branching streamlets with mosses and other plants connected with springs, or with transitions to bog-formations. On the rock terraces there is sometimes a soil-layer which, according to the conditions of moisture, supports either Gramineæ or Cyperaceæ. Therefore, on mountain-slopes, many different plant-formations are found in patches close to one another in many transitional stages. In the rock-detritus on mountain slopes which are not too steep, plants common on rocky flats occur, but none that are really characteristic: the following have been noted: *Silene acaulis*, *S. maritima*, *Alchimilla alpina*, *Dryas octopetala*, *Thymus serpyllum*, *Cerastium alpinum*, *Armeria maritima*, *Saxifraga cæspitosa*, *S. hypnoides*, *S. stellaris*, *Potentilla maculata*, *P. anserina*, *Sedum acre*, *Erigeron alpinus*, *Veronica saxatilis*, *Poa glauca*, *P. alpina*, and several others. Nor are there many characteristic plants in the vegetation of the rock-faces. Tuff and breccia mountains are generally richer in plants than basalt mountains, their surfaces having many more crevices and hollows in which plants can gain foothold. The following plants occur on steep mountain-sides: *Archangelica officinalis*, *Rhodiola rosea*, *Haloscias scoticum*, *Polypodium vulgare* and *Woodsia ilvensis*, also *Cochlearia officinalis*, especially on sea-fowl cliffs; *Saxifraga Cotyledon* grows only on rocks in south-eastern Iceland. Moreover, in rock-clefts various ferns occur, most frequently *Cystopteris*

fragilis, but also flowering plants, such as *Sedum annuum*, *Oxyria digyna*, *Plantago maritima*, *Saxifraga cæspitosa*, *Poa glauca*, *Festuca ovina*, and others. On damp rock-faces near large waterfalls these same species are met with, often as large, well-developed specimens (H. Jonsson, 1905, p. 30): also *Poa alpina* f. *vivipara*, *Aira alpina*, *Saxifraga hypnoides*, *S. stellaris*, *S. nivalis*, *S. cæspitosa* and several



Fig. 31. The river Thverá in Öxnadal. *Epilobium latifolium* and *Aira* on a small gravel-island in the river; July, 1909.

(Phot. A. Hesselbo.)

species of mosses. Nowhere is seen so mixed and variegated a plant-society as on extensive, fairly densely plant-covered mountain slopes where the majority of the plant-formations are met with, in patches, side by side. On a talus of fallen blocks and débris (urð) there is often a considerable vegetation of lichens, mosses and liverworts. In some places, especially far up on the mountains, the sloping heaps of rock-fragments are poor in plants; in other places they carry a rich vegetation of ferns or willows and birch shrubs and heather, with a variable admixture of herbaceous plants from different formations, with no special character, the vegetation resembling closely that which occurs in ravines and lava-clefts.

Where the conditions of life are specially favourable; where the

situation is suited to plant-life with southern exposure, an adequate supply of water, shelter from sharp winds, and intense sunlight during spring a "herb-slope" (Urteli¹) or "herb-flat" (Urtemark) is formed which on the one hand passes gradually into a rocky-flat formation, and on the other into a birch coppice; it chiefly contains the plants of these two formations, but the growth is dense and luxuriant, so that the ground often appears to be entirely covered by the closely-placed plants. Dicotyledonous flowering plants are the most important, grasses are absent or of subordinate importance. The soil consists of clay or gravel mixed with humus, upon which mosses sometimes occur. Such herb-slopes are found in patches on mountain-sides, on basalt-terraces or on the inclines below rocks, in large ravines and in sheltered, sunny hollows; they often form beautiful carpets, in which the various species usually occur intermixed with each other. As a rule, the dominant species are *Geranium silvaticum*, *Spiræa ulmaria*, *Archangelica officinalis*, *Angelica silvestris*, *Geum rivale*, *Bartschia alpina*, *Alchimilla vulgaris*, *Brunella vulgaris*, *Rubus saxatilis*, *Vicia cracca*, *Myosotis arvensis*, *Leontodon autumnalis*, several species of *Hieracium*, *Rumex acetosa*, *Ranunculus acer*, *Poa*, *Agrostis* and *Aira*; intermixed with these occur several other species, but less frequently. In some parts of the island other characteristic species are frequently noted in "herb-slopes," for instance in East Iceland, *Campanula rotundifolia* and *Saxifraga aizoides*, and in some places in South Iceland *Valeriana officinalis* and *Lychnis flos cuculi*.

Sand-covered tracts (sandar). As already mentioned, sandy tracts occupy vast areas — several thousand kilometres surface — in Iceland, both in the lowlands and on the plateau. The physical conditions of these "sandar" differ somewhat, therefore their vegetation, although usually homogeneous and poor in species, may now and then vary somewhat in details. The vast sandy wastes below the glacier-bearing mountains (Jökulls) of South Iceland are mainly formed of glacio-fluvial gravel and sand, but also partly of volcanic ashes and scoriæ, while there are wide stretches upon which both the fine and the coarse gravel is mixed with clay. Sometimes extensive stretches are occupied by alternating clayey flats and pebble-covered river-beds; there are also tracts strewn with ice-striated boulders, and extensive areas, especially on the plateau, covered

¹ Urteli (herb-slope) and Græsli (grass-slope; see p. 335) denote plant-covered slopes where dicotyledonous flowering plants and grasses are dominant respectively.

with blown sand. Where the sand-covered tracts reach the shore their outermost border supports a halophilous vegetation which, at a short distance from the coast, is replaced by the common plants of sandy soil and rocky flats. On gravelly tracts of sand in the lowlands the following plants are the commonest: *Silene maritima*, *Armeria maritima*, *Festuca rubra*, v. *arenaria*, *Carex incurva*, *Agrostis alba*, *Juncus balticus*, *Elymus arenarius* and *Potentilla anserina*; also *Galium verum* and *Thymus serpyllum*, often occurring in patches. Although the vast stretches of glacial sand in South Iceland have a fairly variable surface yet they are extremely poor in plant-life; owing to "glacier-bursts," and to glacier-rivers constantly causing floods and changing their courses, the vegetation has rarely the chance of development. On Skeidarársandur (cf. H. Jónsson, 1905, pp. 20—22) the following plants occur widely scattered: *Chamænerium latifolium*, *Arabis petræa*, *Silene maritima*, *Saxifraga oppositifolia*, *S. cæspitosa* and *Poa glauca*, also small patches of *Grimmia hypnoides*; but there are, in addition, large stretches quite naked and entirely destitute of plant-life. The main part of Myrdalsandur is a desert almost devoid of vegetation; far apart occur a few specimens of *Arabis petræa*, *Silene maritima* and *Elymus arenarius*; usually there is no vestige of plant-life, and one may ride for hours without seeing a single plant. In a few localities in Breidamerkursandur and Skeidarársandur there is open grass-vegetation in small oases where the sandy gravel from some cause or another has for some length of time escaped inundation by the ice-cold glacier water; in such places, in addition to *Chamænerium latifolium* there occurs usually *Agrostis alba*, *Poa alpina*, *P. glauca*, *Aira alpina*, *Calamagrostis stricta*, *Festuca ovina*, *F. rubra* v. *arenaria*, *Carex incurva*, *Juncus balticus*, *J. triglumis*, *Luzula spicata*, *Salix lanata*, *Oxyria digyna* and others. As may be seen, there is nothing specially characteristic in the vegetation of these tracts of glacial sand and if they were rescued from the destructive effect of the glacier-rivers, they would quickly become covered by the various plant-formations of the level country; we have already mentioned one such instance, when Brunasandur in 1783 was rescued from the inundations of glacier-rivers by a lava-stream, which pushed a large river aside.

Blown sand supports a somewhat more peculiar flora, the characteristic plant being *Elymus arenarius*; but where it is very mobile, as e. g. on the plateau in the neighbourhood of Fiskivötn and between Tungná and Skaftá, no plant-life can thrive on it.

Where the sand becomes more stable, or there is shelter, *Elymus arenarius* appears, often associated with *Festuca rubra* v. *arenaria*; not until the sand becomes somewhat fixed do other species appear, e. g. *Juncus balticus*, *Carex incurva*, *Agrostis alba*, *Festuca ovina*, *Silene maritima*, *Salix lanata*, *S. glauca* and occasionally *Halianthus peploides* in localities not too far away from the coast. Extensive



Fig. 32. *Salix lanata* and, in the background, *Betula odorata* growing in black blown-sand (volcanic ash) near Jökulsá, between 'As and Svinadal; July, 1909.

(Phot. A. Hesselbo.)

tracts are covered with different *Salices*, especially in Fjallasveit, where in some places on sandy flats *Carex incurva* also occurs in abundance; moreover, in Myvatnsöræfi, Sudurárbotnar, Rangárvellir, and several other places. Where the soil is broken up and removed by sand-storms as deep down as to the underlying gravel, as in several places in the southern lowlands in the neighbourhood of Hekla, small tufts of *Festuca rubra* and *F. ovina* are the first to appear, then come *Juncus balticus*, *Equisetum arvense*, *Agrostis alba*, *Silene maritima*, *Salix lanata* and *S. glauca*; then gradually several species of grasses make their appearance until at last a grassy willow-flat is formed which makes an excellent sheep pasture. Here and there on the plateau are damp flats of old blown-sand inter-

sected with clefts, rent by frost, which are filled with *Grimmias* and *Salix herbacea*.

The flora of the lava-streams cannot be referred to any single plant-formation, because according to the age and the progressive development of the vegetation, the lava may bear on it all possible kinds of plant-formations. Nevertheless in Iceland several plants

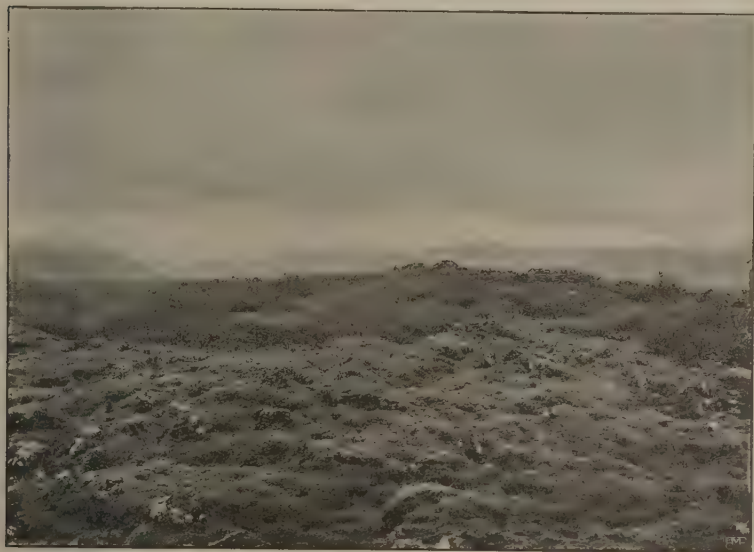


Fig. 33. Lava-field in Nordrárdal in the district of Borgarfjörð (Aug. 3, 1909). The lava is covered to a depth of one foot with a layer of *Grimmia hypnoides*. Projecting parts of the lava are covered with crustaceous lichens. Here and there a tuft of *Festuca ovina*. Birch coppice in the background.

(Phot. A. Hesselbo.)

are more particularly associated with lava-streams and have there found shelter in the numerous clefts and depressions, where conditions of life are especially suitable for them. *Paris quadrifolia* is found only on lava-streams, and also ferns are found, in abundance and often as very large specimens. *Aspidium filix mas*, *A. spinulosum*, *A. lonchitis* and *A. phegopteris* very rarely occur in other habitats than lava-clefts; *Athyrium filix femina*, *Woodsia ilvensis*, *Polypodium vulgare*, *Aspidium dryopteris* and *Cystopteris fragilis* are also common in lava-clefts, although they are also met with fairly often in other localities, between blocks of rock and in rock-clefts. *Milium effusum* occurs also most frequently in lava-clefts. On lava-

streams there is a good opportunity of studying the development of the different plant-formations and plant-societies because, at the beginning, every lava-stream is virgin soil, where plant-life must break entirely new ground. The first establishment of vegetation is due to mosses and lichens: on the 23-years-old Krakatindsbraun Dr. H. Jónsson found twelve species of mosses, three of lichens and one alga. Two of the lichen-species, *Stereocaulon alpinum* and *Squamaria gelida*, were widely distributed on lava-domes, the mosses usually occurred in clefts, but nowhere had a moss-carpet yet developed (H. Jónsson, 1905, pp. 55—56). The next stage is the *Grimmia*-heath, which occurs as a continuous covering over the low-lying parts of the lava, while crustaceous lichens form crusts upon the protruding points; the *Grimmias* form the soil-layer which is primarily necessary for the growth of higher plants. In this moss-foundation occur several lichens and scattered specimens of flowering plants from different associations. After this the development on the lava-streams in the lowlands proceeds in various directions according to the surface-conditions of the lava, the nature of the rock and other circumstances, such as the greater or less amount of drifted sand or humus which has settled upon the surface, and whether a supply of water is available, etc. Consequently, in the course of time a lava-stream may support either a heather-moor, a coppice-wood, a "herb-flat", or grassland, or all these plant-formations may be simultaneously present on the same lava-stream. Rocky-flat formations proper, do not occur on lava-streams, except very rarely, when the lava-streams become covered with gravel brought down by mountain streams or glacier rivers. On the plateau the vegetation on a great many of the lava-streams does not go beyond the lichen-stage, on others a considerable number of *Grimmias* are present, but almost never as a continuous covering, such as they form in many places in the lowlands and especially on the peninsula of Reykjanes. On the other hand the lava-streams of the plateau are frequently covered with drifted sand and support a sand-vegetation which at higher levels consists of *Elymus arenarius* and at lower levels of different *Salices*. There are a few instances of old, partially blocked and sand-covered lava-streams in the valleys, in localities where water was abundantly present, forming the substratum of swampy grassland with peat. Thus, in the course of time, a lava-stream may give rise to almost any formation¹.

¹ For further information regarding plant-life on lava-streams see H. Jóns-

The *Grimmia*-heath formation is co-ordinate with the rocky-flat formation, but is not so widely distributed by a great deal as is the latter. As already mentioned, it reaches its fullest development on the lava-streams in the lowlands, especially in the peninsula of Reykjanes, where it occupies vast areas; but it also occurs on many other lava-streams. Where there are sand-drifts *Grimmia*-carpets occur very sparsely or are entirely absent, as *Grimmia hypnoides*, the most common species, cannot thrive in drifting sand; therefore extensive areas around Hekla, Fiskivötn and several other places are practically bare of mosses. On the vast lava-fields on the plateau mosses occur very sparingly. In several places the *Grimmia*-heaths on the lava-streams of the lowlands are comparatively quickly transformed into soil for higher plants, which are fairly numerous even in the *Grimmia*-carpet; generally the latter, in the course of time, passes into heather-moor; sometimes into patches of grassland. In several places the *Grimmia*-heath covers, with its characteristic grey carpet, stony mountain-slopes, and areas strewn with rock fragments, and, as is the case with the rocky flat, forms the foundation of a scattered vegetation of many different species, without any special character, but dependent upon the plant-formations of the neighbourhood. Usually the *Grimmia*-heath develops more quickly into heather-moor or grassland than does the rocky-flat formation, owing to the abundant material for soil-formation supplied by the mosses. *Grimmia*-heaths occupy large areas in the lower part of the plateau, but very few flowering plants are found there in them; on the other hand, lichens often occur numerously, especially *Cetraria* and *Cladonia*, not however so numerously that they form a lichen-heath proper, which occurs in Iceland only in patches, and is of no great importance. In the highest parts of the interior of Iceland the *Grimmia*-heath formation is of much less importance than in the lower part of the plateau.

Grassland. Ground covered chiefly with grasses or grass-like plants may be classified under four heads: grass-slopes (Græsli); knolly grassland (Græsmo); flat uncultivated grassland; and home-fields, artificially manured soil. Grass-slopes (Græsli). The lower

son: Gróðrarsaga hraunanna á Íslandi (Skirnir, 1906, pp. 150–163); Vegetation paa Snæfellsnes (Vid. Medd. Nat. Foren., 1900, pp. 81–84), and Vegetation i Syd-Island (Bot. Tidsskr., 27 Bd., 1905, pp. 53–61). C. H. Ostenfeld: Skildringer af Vegetationen paa Island (Bot. Tidsskr., 22 Bd., 1899, pp. 245–253). Chr. Grönlund: Karakteristik af Plantevæxten paa Island, pp. 30–32.

slopes of mountains are often grass-covered, especially when the rock is tuff or breccia; in South Iceland the tuff mountains are often entirely grass-covered, at least on the southern side, and sometimes they are covered with a thick layer of soil without knolls proper, which occur only on the clay ground of the lowlands. But sometimes wavy rows of small knolls, or narrow ripple-like ledges occur in the lowest part of the grass-slope, and sometimes above these, for a great distance up, the surface of the soil is undulating and wave-like; this is undoubtedly due to mud-flows in the clayey soil-covering. On basalt mountains the grass-vegetation extends upwards in tongues or occurs in patches in depressions or on ledges, separated by considerable tracts of stones and gravel. On such a grass-slope, in addition to the grasses, many other kinds of herbaceous plants are more or less numerously represented. In South Iceland, according to H. Jónsson, the following are the dominant species: *Agrostis vulgaris*, *A. canina*, *Anthoxanthum odoratum*, *Festuca ovina*, *Poa alpina*, *P. nemoralis*, *Geranium silvaticum*, *Trifolium repens*, *Brunella vulgaris* and *Leontodon autumnalis*; less common, but often occurring locally in great abundance: *Spiræa ulmaria*, *Linum catharticum*, *Rubus saxatilis*, *Gentiana campestris*, *Myosotis arvensis*, *Parnassia palustris*, and many others; in Fljotshlid *Carum carvi* is very common and in Myrdalur and Sida *Succisa pratensis*. The vegetation is rich in species and is rather mixed, although grasses preponderate. In other parts of the country where basalt is dominant the grass vegetation of the mountain-slopes consists of similar species, but is not so luxuriant as in South Iceland. The following species are common: *Agrostis vulgaris*, *A. alba*, *A. canina*, *Anthoxanthum odoratum*, *Nardus stricta*, *Aira flexuosa*, *A. cæspitosa*, *Phleum pratense*, *Poa alpina*, *Hierochloa borealis*, *Festuca rubra*, etc. A special *Nardus*-association and an *Anthoxanthum*-association often occur.

Knolly grassland (Græsmo). By this is understood dry, extremely knolly stretches of clayey ground intermixed with humus, occurring on level land and in valleys with a mixed vegetation of Gramineæ, Juncaceæ and Cyperaceæ; it may therefore differ considerably in appearance, according to which of these families predominates. When grasses predominate the "Græsmo" resembles grassland, but sometimes *Juncus trifidus* and *Elyna Bellardi* are so dominant that large stretches attain a brownish tint like that of a heather-moor. Usually, the vegetation of the knolls differs from that of the depressions; in the depressions, mosses and some *Carices*

are often met with, but upon the knolls there are *Elyna Bellardi* and *Juncus trifidus*; sometimes these are intermixed with mosses and lichens. In some places *Juncus balticus* predominates, in others *Luzula* or *Agrostis*, *Aira cæspitosa*, *Trisetum subspicatum* and other grasses.

The dry uncultivated grassland without knolls (*hardvelli*, *vallendi*) usually has for a substratum coarse sand, river-gravel, pebbles, etc., with a thin covering of humus, and a low and rather open vegetation which chiefly consists of Gramineæ (*Festuca*, *Aira*, *Poa* and *Agrostis*), but these are abundantly intermixed with *Juncus balticus*, *Luzula multiflora* and *L. spicata* and *Elyna Bellardi*; *Festuca rubra* is sometimes a dominant species. Of dicotyledonous plants the following are common: *Leontodon autumnalis*, *Thalictrum alpinum*, *Draba verna*, *Galium verum*, *Euphrasia officinalis*, *Viola tricolor*, *Gentiana campestris*, *Achillea millefolium*, *Rhinanthus minor*, and others.

The home-field (*tun*) is the manured grassland round the farm-buildings. It is usually enclosed and generally abounds in large knolls. In 1909 the area of the home-fields throughout the island was estimated at 188 square kilometres. The hay (*tada*) from these home-fields is kept chiefly for winter-fodder for cows. The cultivation of the home-fields differs greatly, which again influences the vegetation, other plant-associations occurring in patches in the grass-covered area of the home-field; these are especially dependent upon the degree of moisture contained in the different parts of the field. In really well-cultivated home-fields throughout the country the vegetation is everywhere homogeneous. The Gramineæ are dominant, especially *Aira cæspitosa*, *Poa pratensis* and *Festuca rubra*; moreover *Festuca ovina*, *Poa trivialis*, *P. annua*, *Agrostis vulgaris*, *Alopecurus geniculatus* and *Anthoxanthum odoratum* are very common, and intermixed abundantly with these occur *Ranunculus acer*, *Taraxacum officinale*, *Rumex acetosa* and *Polygonum viviparum*. The home-fields are often quite yellow with *Ranunculi* (*R. acer* and *R. repens*); in many places *Trifolium repens* and *Rhinanthus minor* also occur abundantly. In some places *Viola tricolor* is abundant in home-fields, especially in *Eyjafjörður*, and *Geranium silvaticum* in some places in *Myrdalur*, and in other places *Vicia cracca*, etc. In addition, many other plants are found in patches, according to the dampness of the soil and the care given to the cultivation of the home-fields; in dry and sandy grassland there often occur an abundance of *Galium verum*, *G. silvestre*, *G. boreale*, *Achillea millefolium*, *Leontodon autumnalis*,

Armeria maritima, as also *Luzula*, *Elyna*, etc.; in damp home-fields are found *Caltha palustris*, *Cardamine pratensis*, *Koenigia islandica*, *Montia rivularis* and different *Carices*. Moreover, a great many species often immigrate from the plant-formations of the neighbourhood; in some places, in badly kept home-fields, even swamp vegetation and willow-coppices or heather may be met with in patches. The



Fig. 34. Outer edge of the home-field (tun) of the farmstead Hnausar in Vatnsdal. *Matricaria inodora* and *Capsella Bursa pastoris*; in the background *Rumex domesticus*; July 28, 1909. (Phot. A. Hesselbo.)

farm-buildings are, as a rule, in the centre of the home-field, and around them there is almost always a characteristic vegetation consisting of *Alopecurus geniculatus*, *Glyceria distans*, *Ranunculus repens*, *Poa annua* and *P. trivialis*; quite near to the home and stables grow *Stellaria media*, *Capsella bursa pastoris*, *Polygonum aviculare*, *Rumex domesticus*, etc. Around farmsteads in the vicinity of the sea, and on islands, are often found in addition *Cochlearia officinalis*, *Cakile maritima* and *Atriplex patula*. In Iceland the walls and roofs of peasants' houses are generally built of turf and are therefore overgrown with various grasses, especially *Glyceria distans*. Flowering plants also often occur upon houses; they vary in the different districts; in south-west Iceland *Matricaria inodora* grows luxuriantly

on the roofs and in some places *Achillea millefolium*; in various districts *Rhodiola rosea* has been planted on the walls, and in the northermost districts *Cochlearia officinalis* often occurs in abundance upon the houses, and in some places *Saxifraga rivularis*. At their base the house-walls are green with *Prasiola crispa*; various mosses also grow upon the houses, especially *Bryum argenteum*¹.

Heather moors are extensively developed in Iceland both in the lowlands and valleys, on mountain-sides and on hills to a height of about 400 metres; they are not recorded from higher levels. On mountain-sides and on hill-slopes the heather moor is almost flat, on level land it is usually knolly; it is best developed upon old lava-streams and it often forms the ground vegetation of birch coppices. The dominant species are *Empetrum nigrum*, *Vaccinium uliginosum*, *V. myrtillus*, *Arctostaphylus uva ursi* and *Calluna vulgaris*; the last species is fairly common in many districts, but never occurs so abundantly as the others. Moreover, among the heather there is usually an abundance of *Dryas octopetala*, *Juniperus communis*, *Betula nana*, *Rubus saxatilis* and *Salix herbacea*. In heathy tracts at higher levels and also above these in scattered patches, are found *Loiseleuria procumbens*, *Cassiope hypnoides* and *Sibbaldia procumbens*. On the peninsulas on either side of Eyjafljörður patches of *Phyllodoce coerulescens* — which is not recorded from more southerly habitats — are now and then found. There is a great variation in the distribution of the different character-plants in the heather moor; sometimes they all occur mixed with each other; sometimes each occurs separately in large or small patches, so that the different areas may be designated *Vaccinium* heaths, *Empetrum* heaths, *Calluna* heaths, *Arctostaphylus* heaths, etc. Between the heather, as ground vegetation, other plants occur in abundance, especially immigrants from the knolly grass-land — from which the knolly heather-land often appears to have been derived — for instance, *Juncus trifidus*, *Elyna Bellardi*, *Luzula multiflora*, *L. spicata*, *Nardus stricta*, *Agrostis canina*, *A. alba* and several other Gramineæ, also *Salix lanata*, *S. glauca*, *S. phylicifolia*, *Silene acaulis*, *Thymus serpyllum*, *Bartschia alpina*, *Alchemilla alpina*, *Thalictrum*, *Galium*, *Hieracium*, and many others. In addition, there is very often a moss-carpet of *Grimmia hypnoides* beneath the heather.

Willow coppices. Although the various species of willows are widely distributed they rarely form coppices proper, and willow

¹ As regards the moss-vegetation on old house-walls see Helgi Jónsson's above-mentioned paper on the vegetation of South Iceland, 1905, p. 54.

coppices, as independent formations, have but a slight distribution in Iceland. As stated above, *Salix lanata* and *S. glauca* are distributed over extensive sandy areas, and occur there, together with some other plants, as dominants; in other places they occur on dry, flat, clayey tracts, as scattered shrubs of low growth (20—60 cm.) with an undergrowth of heather, *Elyna Bellardi*, various species of grasses, etc. It is chiefly *Salix phylicifolia* which forms coppices

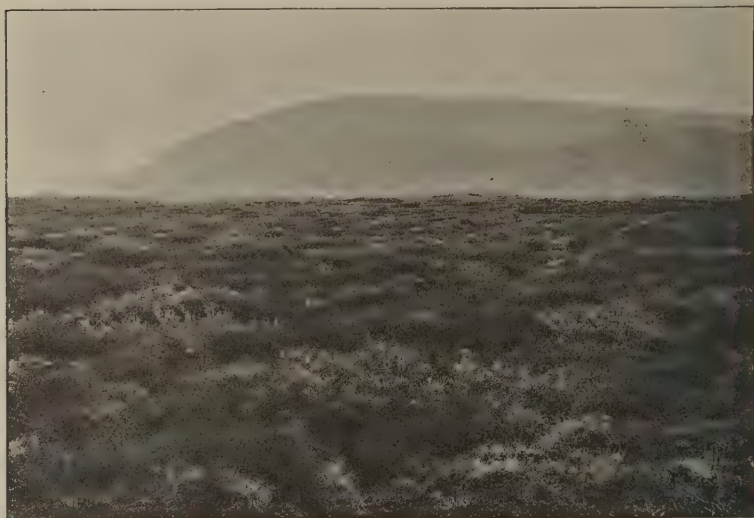


Fig. 35. Knolly moor of *Betula nana* intermixed with *Salix lanata* and *Salix phylicifolia*. Ground vegetation: *Empetrum*, *Arctostaphylus uva ursi*, *Anthoxanthum odoratum* and *Polygonum viviparum*. (Phot. A. Hesselbo.)

(e. g. near Skaftafell, Fnjóskadalur, Hrafnkelsdalur, Kaldalón and Mývatn) in association with *Salix lanata* and *Betula odorata* and with a rich ground-vegetation of highly diverse plants common on "herb-flats." Now and then *Salix phylicifolia* forms the undergrowth of birch coppices, as for instance, in Bæjarstadaskogur near Øræfi; the willows here have an average height of 2 metres; the highest individuals are 3 metres in height, but the stems are only 18—24 cm. in circumference. *Salix phylicifolia* (often together with *Salix lanata*, which may attain a height of 1—1½ metres) is often found interspersed in birch coppices, in many places in different districts. In several places near Mývatn *Salix phylicifolia* forms coppices, among other places in Sluttnes, where a stem which I measured in 1882,

had a circumference of 21 cm. and a length of 5 metres, but it could not stand erect.

Birch coppices. An account has already been given of the distribution of birch coppices in Iceland, and in a subsequent part

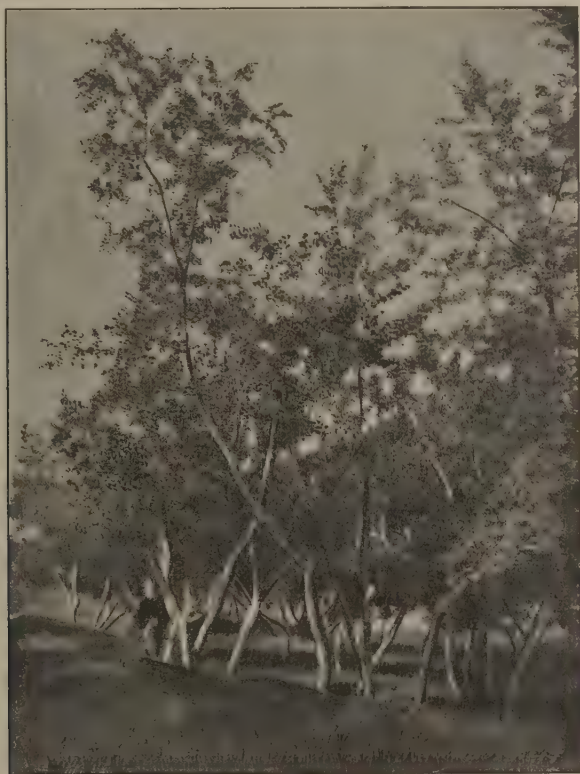


Fig. 36. Hallormstadvágur; 1894 (see text).
(Phot. Th. Thoroddsen.)

of this work there will no doubt be an exhaustive description of tree-distribution in Iceland, so here only a few very brief notes on the subject will be given. The greater part of the birch coppices in Iceland consists of stunted shrubs having, as a rule, a height of 1—3 metres only, sometimes even lower; a fact which is undoubtedly due to the destructive habits of sheep. Well-grown birches — the remains of woods which have formerly been far more extensive — occur, however, in a few localities. Of such woods the following

are the most important: Hallormstadaskógur near Lagarfljót in East Iceland, Bæjarstadaskógur below Jökulfell in Øræfi in South Iceland, and Thórdarstadaskógur and Hálsskógur in Fnjóskadal in North Iceland. In Hallormstadaskógur some erect birch trees have a height of 8—9 metres and a circumference of 70—80 cm., and many others have a height of 5—7 metres. In Thórdarstadaskógur the highest tree is 8½ metres high, with a circumference of 32 cm.; several of the trees are 6—7 metres high, and the average height of the whole wood is 3—4 metres. Hálsskógur is somewhat lower; some of the trees are, however, 6—7 metres high, and several 4—5 metres¹. Bæjarstadaskógur is somewhat lower, but the trees are well-grown and erect, and stunted birches are absent; the average height of the birch trees is 4—5 metres and may often be as much as 6 metres². In a ravine near Skaftafell I measured in 1894 a birch tree which was 7 metres high and a mountain ash which had a height of 9½ metres. This tree occurs sometimes dispersed in birch coppices, and sometimes separately in ravines and on mountain slopes; it has often been allowed to stand on account of some superstition. In some places in North and South Iceland the mountain ash (*Sorbus aucuparia*) has been planted around farmsteads and by houses in towns. It attains a height of 7—10 metres, but in birch coppices it is generally only 4—5 metres, or even less. In birch coppices are also found *Betula nana*, *Salix phylicifolia*, *S. lanata* and *S. glauca* and *Juniperus communis*. The soil in coppice-woods consists often of "moar" — knolly clay which rests sometimes on gravel and sometimes upon rock. Coppices often occur also on a stony bottom, as in ravines, between rocky boulders, and often upon mountain slopes — occasionally they are found on boggy soil. The wood-floor is very often occupied by heather moor; and birch coppices of lower growth often even pass into heather moor; in the latter case the same species are found in the woods as are found on ordinary heather moors, and they form similar associations³.

¹ S. Sigurdsson: Skógarnir í Fnjóskadal (Andvari, XXV, 1900, pp. 144—175).

² H. Jónsson, 1905, pp. 46—50. Th. Thoroddsen in Geografisk Tidsskrift, XIII, 1895, pp. 16—17.

³ During latter years many papers have been written on the woods of Iceland. One of the most important is that by C. V. Prytz: Skovdyrkning paa Island in Tidsskrift for Skovvæsen, vol. XVII, 1905, pp. 20—89; it also contains interesting notes on the Icelandic soil. Moreover, works dealing with the woods of Iceland are enumerated in Lysing Islands, vol. 2, on pp. 443—445.

Sometimes the trees grow in grassland, and sometimes on "herb-flats;" occasionally the wood-floor consists of mosses. In grassland the commonest species are *Agrostis vulgaris*, *Aira flexuosa* and *Anthoxanthum odoratum* and other more scattered Gramineæ. Where the herb-flat formation is dominant many different species occur, especially *Spiræa ulmaria*, *Angelica silvestris*, *Rubus saxatilis*, *Leontodon autumnalis*, *Geranium silvaticum*, *Bartschia alpina*, *Myosotis arvensis*, *Alchimilla vulgaris*, *Fragaria vesca*, and others. *Trientalis europæa* grows here and there in woods in East Iceland only. Where mosses are dominant on the wood-floor the vegetation consists chiefly of *Hylocomium* (H. Jónsson, 1900, p. 76). On the whole, in coppices, scattered individuals of the numerous species from the different formations in the neighbourhood may be found.

3.

MARINE DIATOMS FROM THE
COASTS OF ICELAND

BY

ERNST ØSTRUP

WITH ONE PLATE

THE material used for this paper has been entrusted to me for examination by the Botanical Garden, Copenhagen. It embraces in all 438 samples collected by the following: cand. O. Davidsen (O. D. †), Dr. phil. Helgi Jónsson (H. Js.), Professor Chr. Grønlund (Grld. †), Mag. scient. R. Hørring (Hør.), Inspector W. Lundbeck (Lb.), Dr. phil. C. H. Ostenfeld (C. H. O.), Dr. phil. O. Paulsen (O. P.) and Adjunkt B. Sæmundsson (B. S.).*)

Dr. Thoroddsen has given me valuable assistance as regards the spelling of the names of the various localities, and has also shewn me the kindness to go through my list of names, without which my paper, in this respect, would scarcely have been in agreement with his work: The Botany of Iceland I, and for this assistance I tender him my hearty thanks. As regards the habitats given by the various collectors, I have specified these when a form appears in up to 3 samples, by adding the parts of the coast where it has been collected, as well as the name of the finder. In case a form is found in more than 3 samples, the number of samples and the parts of the coast are given only. As to the limitation of the different parts of the coast, see Helgi Jónsson, the Botany of Iceland I, 1, page 6, and the map page 7. The samples are, according to the parts of the coast, apportioned as follows:

South,	given in the text as S.	58 samples
South-West —	- - — - S.W.	191 —
North-West —	- - — - N.W.	30 —
North —	- - — - N.	98 —
East —	- - — - E.	53 —
No locality —	- - — - S. L. (sine loco)	8 —
Total.....		438 samples

*) The letters in brackets affixed to the names of the collectors indicate the abbreviations of their names, as used in the text; a † signifies, that the person is by now deceased.

The names Europe, Africa, Asia, America, Australia, Greenland, Arctic Seas are abbreviated in the text respectively as follows: Eu., Afr., As., Am., Austr., Grl., A. S.

Freshwater forms are frequently found in the samples examined from the coasts of Iceland; these are however excluded in this paper, but will be included in a future work dealing with the fresh-water diatoms of Iceland. On the other hand, several forms found in brackish water are here included.

PENNATÆ

Diraphideæ

Tropidoneis Cl. 1891. Cl. Syn., I, 22.

Tropidoneis lepidoptera (Greg.) Cl. Cl. Syn., I, 25; V. H. Trt., Tab. V, fig. 287 (*Amphiprora* lep.).

Stykkishólmur (S.W.), H. Js.

Area: Ubiquist, A. S.

Pleurosigma W. Sm. 1853. Cl. Syn. I, 32.

Pleurosigma cuspidatum Cl. Cl. Syn. I, 35; Per. Pleur., Tab. V, fig. 16 (*P. lanceolatum* var. *cuspid.*).

Skálholtsvik (N.), H. Js.

Area: Eur., Aust.

Pleurosigma elongatum W. Sm. Cl. Syn. I, 38; V. H. Trt., Tab. VI, fig. 262.

7 samples (S.W. 4, N. 1, E. 2).

Area: Ubiquist, Grl., A. S.

Pleurosigma longum Cl. Cl. Syn. I, 38; Cl. & Gr. A. D., Tab. III, fig. 71.

Skórðarstræumur (S.W.), H. Js.

Area: Grl., A. S.

Pleurosigma Nubecula W. Sm. Cl. Syn. I, 34; W. Sm. Syn., Tab. XXI, fig. 201.

Skálholtsvik (N.), H. Js.

Area: Eur., Afr., As., Am., Grl.

Pleurosigma Stuxbergi Cl. & Grun. Cl. Syn. I, 41; Grun. Fz. J. L., Tab. I., fig. 56.

Reykjavik (S.W.), H. Js.

Area: Grl., A. S.

Caloneis Cl. 1894. Cl. Syn., I, 46.

Caloneis brevis (Greg.) Cl. Cl. Syn. I, 61; V. H. Trt., Tab. IV, fig. 180 (Navicula br.).

Aðalvík (N.W.), Lb., Búðir (S.W.), H. Js.

Area: Ubiquist, Grl., A. S.

Caloneis brevis var. *distoma* Grun. forma *latior*, Cl. Syn., l. c.; Cl. & Gr. A. D., Tab. I, fig. 25 (Navicula brevis dist.).

Dyrafjörður (N.W.), C. H. O.

Area: As., A. S.

Caloneis brevis var. *vexans* Grun. Cl. Syn., l. c.; Tab. nost., fig. 1.

Búðir (S.W.), H. Js.

Area: Eur., As., A. S.

I have given a drawing of this species, as it differs somewhat, by its very narrow apical and small central areas from the figures in A. S. N. S. D. tab. II, fig. 14 and fig. 14 in Per. Diat. mar. tab. X. I have not been able to see any punctuations of the striae, as shown in V. H. Syn. tab. XI fig. 18; besides concerning this form see the remarks by Peragallo in D. mar. p. 81.

Caloneis formosa (Greg.) Cl. Cl. Syn. I, 57; V. H. Trt., Tab. V, fig. 199 (Navicula form.).

4 samples (S.W. 3, N.W. 1).

Area: Ubiquist, Grl.

Caloneis Liber (W. Sm.) Cl. var. *genuina* Cl. Cl. Syn., I, 54. V. H. Trt., Tab. V, fig. 219. (Navicula L.).

8 samples (S. 1, S.W. 4, N.W. 3).

Area: Ubiquist, Grl., A. S.

Caloneis Liber var. *elongata* Grun. Cl. Syn., I, 55. A. S. N. S. D., Tab. II, fig. 42 (Navicula elong.).

Reykjavík (S.W.), B. S.

Area: Eur., Afr., As., Am., Grl., A. S.

Caloneis Liber var. *linearis* Grun. Cl. Syn., I, 54; V. H. Trt., Tab. V, fig. 220. (Nav. L. lin.).

8 samples (S.W. 6, N.W. 1, N. 1).

Area: Eur., Afr., As., Am.

Diploneis Ehr. 1840. Cl. Syn., I, 76.

Diploneis æstiva (Donk.) Cl. Cl. Syn., I, 94; A. S. Atl., Tab. VII, fig. 8.

Eyrarbakki (S.W.) H. Js., Dyrafjörður (N.W.) C. H. O., Miðhus(?) H. Js.

Area: Eur., Afr., As., Am., A. S.

Diploneis bomboides A. S. var. *media* Grun. Cl. & Gr. A D., 41, Tab. III, fig. 54.

Steinaklettur (S.W.) H. Js.

Area: Eur., Grl., A. S.

Diploneis chersonensis (Grun.) Cl. Cl. Syn., I, 91; V. H. Trt., Tab. XXVI, fig. 738. (*Navicula chers.*).

8 samples (S. 1, S.W. 5, N.W. 1, N. 1).

Area: Ubiquist.

In a sample (Broddanes (N.) H. Js.) I have found a form, which agrees well with *Navicula apis* (see Per. Diat. mar., 121, tab. XIX, fig. 3—8) which by Cleve l.c. is referred to *Dipl. cherson*.

Diploneis coffæiformis (A. S.) Cl. Cl. Syn., I, 81; A. S. N. S. D., Tab. I, fig. 22.

Grjótnes (N.), C. H. O.

Area: Eur., As., Am., Grl.

Diploneis constricta (Grun.) Cl. Cl. Syn., I, 83; Donk. Br. D., Tab. VII, fig. 6. (*Navicula Musca*).

Isafjörður (N.W.), H. Js.

Area: Eur., As., Am., Grl., A. S.

Diploneis contigua (A. S.) Cl. var. *Eudoxia* A. S. Cl. Syn., I, 83; Per. D. mar., Tab. XVII, fig. 6. (*Navicula E.*) Tab. nost., fig. 2.

Vestmannaeyjar (S.), H. Js.

Area: Eur., Afr., As., Am., A. S.

I have given a drawing of this species, as the form found by me is somewhat more contracted in the middle than the figure shown by Peragallo. The other figures quoted by Cleve l.c. have all approximately rectilinear sides.

Diploneis Crabro (Ehr.) Cl. var. *minuta* Cl. Cl. Syn., I, 102; Per. D. mar., Tab. XV, fig. 7.

Vestmannaeyjar (S.), H. Js., Reykjavik (S.W.), H. Js.

Area: Eur., Aust.

Diploneis didyma (Ehr.) Cl. Cl. Syn., I, 90; V. H. Trt., Tab. III, fig. 147.

Höfði (N.), H. Js.

Area: Ubiquist, Grl., A. S.

Diploneis elliptica (Ktz.) Cl. var. *grandis* Grun. Cl. Syn., I, 92; Pant. Ung. III, Tab. XI, fig. 182 (*Nav. præclara*).

Búðir (S.W.), H. Js.

Area: Eur.

Diploneis fusca (Greg.) Cl. var. *subrectangularis* Cl. Cl. Syn., I, 93; A. S. Atl., Tab. VII, fig. 4.

Brokey (S.W.), H. Js., Dyrafjörður (N.W.), C. H. O.

Area: Eur., As.

Diploneis incurvata (Greg.) Cl. Cl. Syn., I, 84; V. H. Trt., Tab. XXVI, fig. 733. (Navicula inc.).

22 samples (S. 1, S. W. 13, N. W. 3, N. 4, E. 1).

Area: Eur., Afr., Am., A. S.

Diploneis interrupta (Ktz.) Cl. Cl. Syn., I, 84; V. H. Trt., Tab. III, fig. 145. (Nav. int.).

13 samples (S. 7, N. W. 4, N. 1, E. 1).

Area: Ubiquist, Grl., A. S.

Diploneis lineata (Donk.) Cl. Cl. Syn., I, 85; V. H. Trt., Tab. XXVI, fig. 736. (Nav. lin.).

Vestmannaeyjar (S.), H. Js., Reykjavik (S. W.), Grld.

Area: Eur., Afr.

Diploneis littoralis (Donk.) Cl. Cl. Syn., I, 94; A. S. Atl., Tab. VII, fig. 25. (Nav. litt.).

Skógarnes (S. W.), H. Js.

Area: Ubiquist, Grl., A. S.

Diploneis major Cl. Cl. Syn., I, 96; V. H. Trt., Tab. IV, fig. 151. (Nav. Smithi).

Vestmannaeyjar (S.), H. Js.

Area: Ubiquist, Grl.

Diploneis notata sp. nov., Tab. nost., fig. 3.

Long: 41 μ , lat: 18 μ , str. 11 in 10 μ .

Valva elliptica. Sulcis in medio leniter contractis. Linea apicali, utroque in latere costas in medio secante, præsente. Striis in sulcis absentibus, mediæ in valva modo juxta nodulum centrale striæ paucæ abbreviatæqve adsunt.

Vestmannaeyjar (S.), H. Js.

Diploneis Smithi (Bréb.) Cl. Cl. Syn., I, 96; Grun. Fz. J. L., Tab. I, fig. 41. (Nav. Sm. var. borealis f. minor.).

4 samples (S. W. 3, N. 1).

Area: Ubiquist, Grl., A. S.

Diploneis splendida (Greg.) Cl. Cl. Syn., I, 87; A. S. N. S. D., Tab. I, fig. 3 (Nav. subc.).

Steinaklettur (S. W.), H. Js.

Area: Ubiquist, Grl., A. S.

Diploneis subcineta (A. S.) Cl. Cl. Syn., I, 86; V. H. Trt., Tab. XXVI, fig. 737 (Nav. subc.).

7 samples (S. W. 4, N. W. 2, N. 1).

Area: Eur., Afr., Am., Grl., A. S.

Diploneis? inæqualis sp. nov. Tab. nost., fig. 4.

Long: $18\ \mu$, lat: $7\ \mu$.

Valva elliptica. Striis uno in latere valvæ 11 in $10\ \mu$, altero in latere 14 in $10\ \mu$.

Dyrafjörður (N.W.), C. H. O.

It is with great hesitation that I refer this small species to *Diploneis*. It seems closely allied to *Navicula Reichardti* Grun. var. *Tschuttschorum* Cl. Cl. Syn. II, 65; Cl. Vega, tab. XXXVII, fig. 48. Cleve places Nav. Reich. among »*Naviculæ lyratae*«.

In *Diat. mar.* p. 129 Peragallo places Nav. Reich. among *Diploneis*, but remarks as follows: »Cette espèce n'est pas un vrai *Diploneis*, mais ce n'est pas non plus une vraie *lyrée* car il n'y a pas de stries entre les fourches ou aires centrales et le raphé.«

Naviculæ Fusiformes Cl. 1894. Cl. Syn., I, 105.

Navicula Acus Cl. Cl. Syn., I, 106; Per. D. mar., Tab. VIII, fig. 23.

Reykjavik (S.W.), C. H. O.

Area: Eur.

Navicula fusiformis Grun. var. *ostrearia* Gaillon. Cl. Syn., I, 106; V. H. Trt., Tab. XXVII, fig. 769.

4 samples (S. 2, S.W. 2).

Area: Eur., Grl.

Navicula glabra sp. nov. Tab. nost., fig. 5.

Long: $41\ \mu$, lat: $8\ \mu$.

Valva lanceolata. Raphe area augustissima cincta. Poris centralibus raphes distinctis. Structuram ullam valvæ perspicere non potui.

Reykjavik (S.W.), H. Js.

This species somewhat resembles the unnamed *Navicula* (from Hvidingsø), delineated in A. S. N. S. D., tab. III, fig. 8, which in Cleve (Syn. I, 106) is found under the name of Nav. Schmidtii, but Cleve, as well as Peragallo (*Diat. mar.* p. 67) give the number of striae as 17 in $10\ \mu$, consequently a distinct striation, while I have not been able to see any. By great enlargement however the valves assume the peculiar misty appearance, indicating a very fine structure.

Naviculæ Orthostichæ Cleve 1894. Cl. Syn., I, 107.

Navicula halophila Grun. Cl. Syn., I, 109; V. H. Trt., Tab. IV, fig. 191. (*N. cuspidata* v. *hal.*).

Reykjavik (S.W.), C. H. O.

Area: Eur.

Navicula Kryokonites Cl. var.? *islandica* v. nov. Tab. nost., fig. 6.

Long: $45\ \mu$, lat: $8\ \mu$.

Valva anguste-lanceolata. Striis subtilissimis et, qvoad perspicere potui, subradiantibus, media in valva fasciam latam relinquentibus.

Brokey (S.W.), H. Js.

It is with some hesitation I refer this form to *Nav. Kryokonites* Cl. It has no slight outward resemblance to *Nav. Kryok.* var. *subprotracta* Cl. (Cl. Syn. I, 109; Cl. Vega Exp., tab. XXXVII, fig. 46) and has also, in common with this, the fairly broad fascia; it differs partly by being somewhat larger, but especially by the very fine striae, which, as far as I could see, are slightly radiate. *Nav. Kryok. subprotracta* has 22 parallel striae, at right-angles to the raphe, in $10\ \mu$, and is found at Cape Warkarema and off East-Greenland.

Amphipleura Ktz. 1844. Cl. Syn., I, 125.

Amphipleura rutilans Trentepohl. Cl. Syn., I, 126; V. H. Trt., Tab. V, fig. 255. (*Berkeleya Dillwynii* An.).

6 samples (S.W. 2, N.W. 2, N. 2).

Area: Eur., Afr., As., Grl.

Naviculæ Mesolejæ Cleve 1894. Cl. Syn., I, 127.

Naviculæ mutica Ktz. forma *Cohnii* Hilse. Cl. Syn., I, 129; V. H. Trt., Tab. IV, fig. 167. (*Nav. mut.*).

Vestmannaeyjar (S.), H. Js.

Area: Ubiquist, A. S.

Navicula (Dickeia) ulvacea Berk. Cl. Syn., I, 129; V. H. Trt., Tab. XXVII, fig. 781.

Isaffjörður (N.W.), H. Js.

Area: Eur.

Naviculæ Microstigmaticæ Cl. 1894. Cl. Syn., I, 141.

Naviculæ (Schizonema) Grevillei Ag. Cl. Syn., I, 152; V. H. Trt., Tab. V, fig. 243.

24 samples (S.W. 19, N. 4, E. 1).

Area: Eur., As., Am., Grl., A. S.

In conformity with Cleve l. c. I include under *Nav. Grevillei* the following:

Schizonema apiculatum Ag. V. H. Syn., Tab. XVI, figs. 4—8.

Schizonema comoides Ag. V. H. Syn., l. c. fig. 3.

Navicula Delognei H. V. H. V. H. Syn., Tab. XI, fig. 13.

Navicula Libellus Greg. Cl. Syn., I, 153; Donk. Br. D., Tab. IX, fig. 1.

Öndverðarnes (S.W.), H. Js., Flatey (S.W.), H. Js.

Area: Eur., As.

Navicula rhombica Greg. Cl. Syn., I, 152; Greg. T. M. S. IV, Tab. V, fig. 1.

31 samples (S. 5, S.W. 20, N. 3, E. 3).

Area: Eur., As., Grl.

Navicula (Libellus) complanata Grun. var.? cnfr. Cl. Syn., I, 153. 7. Tab. nost., fig. 7.

Long: 56 μ , lat: 10 μ .

Valva lanceolata, apicibus rotundatis. Raphe area hyalina angusta, in medio in areolam rotundatam dilatata, cincta. Striis media in parte valvæ ægre modo perspiciendis, ibique 17 in 10 μ , apices versus densioribus.

Búðir (S.W.), H. Js.

I consider this *Navicula* belonging to the form-series of *N. complanata*, perhaps most closely allied to *N. compl. var. hyperborea* Grun. (see Gr. Fz. J. L., tab. I, fig. 10) of which, as far as I know, no figure exists viewed from the valve-surface.

Stauroneis Ehr. 1843. Cl. Syn., I, 144—151 (sub. Nav. Microst.).

Stauroneis constricta (Ehr.?) W. Sm. Cl. Syn., I, 145; A. S. Atl., Tab. XXVI, figs. 35—39 (St. amphoroides).

4 samples (S.W. 1, N.W. 1, E. 2).

Area: Eur., Am.

Stauroneis Gregorii Ralfs. Cl. Syn., I, 145; V. H. Trt., Tab. I, fig. 52.

Búðir (S.W.), H. Js., Dyrafjörður (N.W.), C. H. O.

Area: Eur., Am.

Stauroneis salina W. Sm. Cl. Syn., I, 145; V. H. Trt., Tab. I, fig. 54.

Olafsvik (S.W.), H. Js., Skálanes (E.), H. Js.

Area: Eur., Afr., Am., Aust., Grl., A. S.

Gomphonema Ag. 1824. Cl. Syn., I, 178.

Gomphonema exiguum Ktz. Cl. Syn., I, 188; Heib. D. D., Tab. V, fig. 18.

91 samples (S. 15, S.W. 40, N.W. 10, N. 16, E. 10).

Area: Eur., As., Grl.

Gomphonema kamtschaticum Grun. Cl. Syn., I, 188; V. H. Syn., Tab. XXV, fig. 29.

28 samples (S. 4, S.W. 9, N.W. 3, N. 5, E. 7).

Area: Grl., A. S.

Gomphonema kamtschaticum Grun. var. *islandicum* v. nov. Tab. nost., fig. 8.

Long: 36 μ , lat: 10 μ . Str. minime 22 in 10 μ .

Valva clavata, apice superiori rotundato. Raphe area hyalina angustissima, in medio in areolam parvam dilatata, cincta. Striis radiantibus, ægre perspiciendis.

Einarslón (S.W.), H. Js., Grimsey (N.), O. D.

Owing to its central area and the radiating striae, I consider this small species more likely allied to *G. kamt.* than to *G. exig.*

Trachyneis Cleve 1894. Cl. Syn., I, 190.

Trachyneis aspera (Ehr.) Cl. var. *intermedia* Grun. Cl. Syn., I, 192; A. S. Atl., Tab. XLVIII, fig. 14 (Nav. asp. int.).

19 samples (S.W. 11, N.W. 3, N. 4, E. 1).

Area: Eur., Am., Grld., A. S.

Trachyneis aspera (Ehr.) var. *pulchella* Cl. Syn. I, 191; W. Sm. Donk. Br. D., Tab. X, fig. 1 (Nav. pulch.).

51 samples (S. 10, S.W. 33, N.W. 3, N. 4, E. 1).

Area: Eur., Aust.

Trachyneis Clepsydra (Donk.) Cl. Cl. Syn., I, 192; A. S. Atl., Tab. XLVIII, figs. 7—8 (no name).

Eyrarbakki (S.), H. Js.

Area: Eur., Am.

Trachyneis velata (A. S.) Cl. Cl. Syn., I, 194; A. S. Atl., Tab. XLVIII, figs. 33—34 (Nav. vel.).

Reykjavik (S.W.), C. H. O., Stykkishólmur (S.W.), H. Js.

Area: Afr., As., Am., Aust.

Naviculæ Lineolatæ Cleve 1895. Cl. Syn., II, 10.

Navicula ammophila Grun. var. *flanatica* Grun. Cl. Syn., II, 30; V. H. Syn., Suppl. A, fig. 17.

Hafnafjörður (S.W.), H. Js.

Area: Eur.

Navicula anglica Ralfs var. *subsalsa* Grun. Cl. Syn., II, 22; V. H. Trt., Tab. III, fig. 137 (N. a. v. subsalina).

Skagafjörður (N.), Grld.

Area: Eur.

Navicula arenaria Donk. var. *arcuata* Per. Per. D. mar. 101, Tab. XIII, figs. 4 & 6.

4 samples (S.W. 3, N.W. 1).

Area: Eur.

Navicula avenacea Bréb. Cl. Syn., II, 15; V. H. Trt., Tab. V, fig. 241. (Schizonema Smithii Ag.)

7 samples (S.W. 3, N.W. 1, N. 2, E. 1).

Area: Eur., Afr., As., Aust., Grl., A. S.

Navicula Bolleana Grun. Cl. Syn., II, 25; A. S. Atl., Tab. XLVII, fig. 18.

Grjótnes (N.). C. H. O.

Area: Eur., Grl., A. S.

Navicula bottnica Grun. Cl. Syn., II, 20; V. H. Syn., Tab. VII, fig. 33.

14 samples (S.W. 6, N.W. 2, N. 2, E. 4).

Area: Eur., Afr., As., Am., Grl., A. S.

Navicula cancellata Donk. Cl. Syn., II, 30; V. H. Trt., Tab. III, fig. 128.

Aðalvík (N.W.), Lb.

Area: Ubiquist, Grl., A. S.

Navicula cancellata Donk. var. *subapiculata* Grun. Cl. Syn., l. c.; A. S. N. S. D., Tab. II, fig. 22 (Nav. Gregorii).

In the same sample as the main species.

Area: Eur., Grl., A. S.

Navicula digito-radiata Greg. Cl. Syn., II, 20; V. H. Trt., Tab. III, fig. 130.

4 samples (all S.W.).

Area: Ubiquist, Grl., A. S.

Navicula digito-radiata Greg. var. *Cyprinus* (Ehr.) W. Sm. Cl. Syn., l. c. V. H. Trt. l. c., fig. 131.

Brokey (S.W.), H. Js., Látravík (N.W.), C. H. O.

Area: Eur., Am., Grl.

Navicula directa W. Sm. var. *genuina* Cl. Cl. Syn., II, 27; V. H. Trt., Tab. XXV, fig. 722.

24 samples (S. 5, S.W. 11, N.W. 3, N. 4, E. 1).

Area: Eur., Afr., As., Am., Grl., A. S.

Navicula directa W. Sm. var. *remota* Grun. Cl. Syn., l. c., A. S. N. S. D., Tab. III, fig. 2 (Nav. (Pinnularia) longa).

Grjótnes (N.), C. H. O.

Area: Eur., Afr., Am., Grl., A. S.

Navicula directa W. Sm. var. *subtilis* Greg. Cl. Syn., l. c.; V. H. Trt., Tab. XXV, fig. 723.

17 samples (S. 3, S.W. 11, N.W. 1, N. 1, E. 1).

Area: Eur., Grl., A. S.

Navicula distans W. Sm. Cl. Syn., II, 35; V. H. Trt., Tab. III, fig. 133.

11 samples (S.W. 10, N. 1).

Area: Eur., Am., Grl., A. S.

Navicula fortis Greg. Cl. Syn., II, 31; Donk. Br. D., Tab. VIII, fig. 8.

Bildudalur (N.W.), H. Js.

Area: Eur., Am., Grl., A. S.

Navicula inflexa Greg. Cl. Syn., 31; Per. D. mar., Tab. XIII, fig. 3.

Olafsvik (S.W.), H. Js.

Area: Eur., A. S.

Navicula lanceolata (Ag.) Ktz. var. *phyllepta* Ktz. Cl. Syn., II, 22; V. H. Trt., Tab. III, fig. 141.

Stykkishólmur (S.W.), H. Js.

Area: Eur.

Navicula peregrina Ehr. Cl. Syn., II, 18; V. H. Trt., Tab. III, fig. 101.

8 samples (S. 1, S.W. 6, N.W. 1).

Area: Eur., Afr., As., Am., Grl., A. S.

Navicula (Schizonema) Bryopsis (Ktz.) Grun. Grun. Bot. Cent. 1509; V. H. Syn., Tab. XV, fig. 26.

6 samples (S.W. 4, N. 2).

Area: Eur.

Navicula (Schizonema) mollis W. Sm. f. *major* Cl. Syn., II, 26; V. H. Syn., Tab. XV, fig. 22.

Fossavik (E.), H. Js.

Area: Eur., Afr., Am., Grl.

Navicula (Schizonema) ramosissima Ag. Cl. Syn., I, 26; V. H. Trt., Tab. V, fig. 244.

35 samples (S. 2, S.W. 18, N.W. 6, N. 6, E. 3).

Area: Eur., Am., Grl.

Navicula (Schizonema) ramosissima forma *amplior* Cl. Syn., l. c.; V. H. Syn., Tab. XV, fig. 3 (Schiz. amplius).

Reykjavik (S.W.), H. Js.

Area: Eur., Afr., Am.

Naviculæ Punctatæ Cleve 1895. Cl. Syn. II, 37.

Navicula granulata Bail. Cl. Syn., II, 48; Per. D. mar., Tab. XXVII, figs. 12—13 (N. Baileyana).

Stykkishólmur (S.W.), H. Js.

Area: Eur., As., Am., Aust., Grl.

Navicula humerosa Bréb. Cl. Syn., II, 43; V. H. Trt., Tab. IV, fig. 182.

6 samples (S. 1, S.W. 2, N.W. 1, N. 2).

Area: Eur., Afr., As., Am., A. S.

Navicula humerosa Bréb. var. *constricta* Cl. Cl. Syn., l. c.; Per. D. mar., Tab. XXVII, fig. 21.

Hafnarfjörður (S.W.), H. Js.

Area: Eur., As.

Navicula latissima Grun. Cl. Syn., II, 43; V. H. Trt., Tab. XXVII, fig. 762.

Vestmannaeyjar (S.), H. Js.

Area: Eur., As., A. S.

Navicula pusilla Greg. Cl. Syn., II, 41; V. H. Trt., Tab. IV, fig. 186.

6 samples (S. 1, S.W. 5).

Area: Ubiquist, A. S.

Naviculæ Lyratæ Cleve 1895. Cl. Syn., II, 52.

Navicula abrupta Greg. Cl. Syn., II, 61; V. H. Trt., Tab. IV, fig. 162.

Dyrasfjörður (N.W.), C. H. O., Aðalvík (N.W., two samples), Lb.

Area: Eur., Afr., As., A. S.

Navicula abrupta Greg. var. *densestriata* var. nov. Tab. nost., fig. 9.

Long: $32\ \mu$, lat: $11\ \mu$, str. 16 in $10\ \mu$.

Valva lineari, apicibus cuneatis. Areis lateralibus angustis, modice procul ab apicibus terminantibus.

Aðalvík (N.W.), Lb.

In spite of its small size and close striation this peculiar species shall probably be placed under the form-series of *Nav. abrupta*, as its short lateral areas especially seem to indicate its place there.

Navicula forcipata Grev. Cl. Syn., II, 65; Per. D. mar., Tab. XXI, fig. 28.

4 samples (S. 1, S.W. 2, N.W. 1).

Area: Eur., Afr., Am., Grl.

Navicula forcipata Grev. var. *densestriata* A. S. Cl. Syn., II, 66; Per. D. mar. l. c., figs. 29—30.

Isafjörður (N.W.), H. Js., Aðalvík (N.W.), Lb., Skagafjörður (N.), Grld.

Area: Eur., Afr., As., Am., Grl.

Navicula Henedyi W. Sm. Cl. Syn., II, 57; V. H. Trt., Tab. IV, fig. 160.

Vestmannaeyjar (S.), H. Js., Búðir (S.W.), H. Js.

Area: Eur., Afr., As., Am., Grl., A. S.

Navicula Hennedyi W. Sm. var. *circumsecta* Grun. Cl. Syn., II, 58; A. S. N. S. D., Tab. I, fig. 42. (N. polysticta var. circ.)

Vestmannaeyjar (S.), H. Js.

Area: Eur., Afr., As., Am., A. S.

Navicula Lyra Ehr. var. *atlantica* A. S. Cl. Syn., II, 63; A. S. N. S. D., Tab. I, fig. 34.

Isafjörður (N.W.), H. Js.

Area: Eur.

Navicula Lyra Ehr. var. *Ehrenbergi* Cl. Cl. Syn., l. c.; V. H. Syn., Tab. X, fig. 1.

Isafjörður (N.W.), H. Js., Dyrafjörður (N.W.) C. H. O.

Area: Ubiquist, Grl., A. S.

Navicula Lyra Ehr. var. *islandica* var. nov. Tab. nost., fig. 10.

Long: $43\ \mu$, lat: $21\ \mu$, str. 11 in $10\ \mu$, subtiliter punctatis.

Valva lineare-elliptica apicibus rotundatis. Areis lateralibus angustis, usque ad apices pertinentibus ibique convergentibus.

Aðalvík (N.W.), Lb.

This form does not correspond completely with any of the numerous previously described variations of *Nav. lyra*. It differs from var. *elliptica* by being more finely striated; from var. *atlantica* by the lateral areas almost reaching the apices, and from var. *Ehrenbergi* by the lateral areas converging at the apices. Perhaps it is most closely allied to *Nav. lyra* var. *granulata* Per. from »la Manche«, delineated, but not described in Per. D. mar., tab. XXIII, fig. 5.

Naviculæ Lævistriatæ Cleve 1895. Cl. Syn., II, 66.

Navicula elegans W. Sm. Cl. Syn., II, 68; Per. D. mar., Tab. X, fig. 25.

4 samples (S.W. 3, E. 1).

Area: Eur., Afr., As., Am.

Navicula palpebralis Bréb. Cl. Syn., II, 70; V. H. Trt., Tab. IV, fig. 175.

7 samples (S. 4, S.W. 2, N.W. 1).

Area: Eur. Afr., As., Am., A. S.

Navicula palpebralis Bréb. var. *angulosa* Greg. Cl. Syn., l. c.; Per. D. mar., Tab. X, fig. 22.

Hvammfjörður (S.W.), H. Js.

Area: Eur.

Pinnularia Ehr. 1843. Cl. Syn., II, 71.

Pinnularia quadratarea A. S. Cl. Syn., II, 95; V. H. Trt., Tab. XXV, fig. 704 (*Navicula* qv.).

Reykjavik (S.W.), C. H. O.

Area: Eur., Am., Aust., Grl., A. S.

Pinnularia Trevelyana Donk. Cl. Syn., II, 98; V. H. Trt., Tab. II, fig. 73 (Nav. Trev.).

Dyrafjörður (N.W.), C. H. O.

Area: Eur., As., Am.

Amphora Ehr. 1840. Cl. Syn., II, 99.

Subgenus *Amphora* Cleve 1895. Cl. Syn., II, 100.

Amphora marina (W. Sm.) H. V. H. Cl. Syn., II, 103; V. H. Trt., Tab. I, fig. 14.

22 samples (S. 3, S.W. 5, N.W. 7, N. 4, E. 3).

Area: Eur., As., Am., Grl., A. S.

Amphora Proteus Greg. Cl. Syn., II, 103; A. S. Atl., Tab. XXVII, fig. 3.

16 samples (S. 1, S.W. 11, N.W. 1, N. 2, E. 1).

Area: Ubiquist, Grl., A. S.

Amphora Proteus Greg. var. *contigua* Cl. Cl. Syn., l. c. A. S. Atl., l. c., figs. 7—9.

10 samples (S. 2, S.W. 7, N.W. 1).

Area: Eur., As., Aust.

Amphora Pusio Cl. Cl. Syn., II, 102; Per. D. mar., Tab. XLIV, fig. 8.

Eyrarbakki (S.), H. Js.

Area: Am., Aust., Grl.

Amphora robusta Greg. Cl. Syn., II, 103; Greg. Cl., Tab. XIII, fig. 79.

Isafjörður (N.W.), C. H. O.

Area: Eur., As., Aust., A. S.

Subgenus *Diplamphora* Cleve 1895. Cl. Syn., II, 107.

Amphora crassa Greg. Cl. Syn., II, 109; A. S. Atl., Tab. XXVIII, figs. 30—33 (A. cr. var. *punctata*).

Vestmannaeyjar (S.), H. Js., Hrótafjörður (N.), H. Js.

Area: Eur., Afr., As., Am., Grl., A. S.

Subgenus *Halamphora* Cleve 1895. Cl. Syn., II, 117.

Amphora exigua Greg. Cl. Syn., II, 123; Greg. Cl., Tab. XII, fig. 75.

Reykjavik (S.W.), H. Js.

Area: Eur., Am., Aust.

Amphora Terroris Ehr. Cl. Syn., II, 122; A. S. Atl., Tab. XXV, fig. 17—19 (A. *cymbifera*).

5 samples (S. 1, S.W. 1, N.W. 1, N. 1, E. 1).

Area: Eur., As., Am., Aust., Grl., A. S.

Subgenus *Oxyamphora* Cleve 1895. Cl. Syn., II, 125.

Amphora lævis Greg. Cl. Syn., II, 130; A. S. Atl., Tab. XXVI, fig. 10.

Olafsvik (S.W.), H. Js.

Area: Eur., As., A. S.

Amphora lineolata Ehr. Cl. Syn., II, 126; V. H. Trt., Tab. I, fig. 10.

Eyrarbakki (S.), H. Js., Reykjavik (S.W.), H. Js., Dyrafjörður (N.W.), C. H. O.

Area: Eur., As., Am., A. S.

Subgenus *Cymbamphora* Cleve 1895. Cl. Syn., II, 134.

Amphora angusta (Greg.) Cl. var. *typica* Cl. Cl. Syn., II, 135; A. S. Atl., Tab. XXV, fig. 15 (A. ang. var. *gracilentia*).

5 samples (S.W. 3, N. 2).

Area: Eur., Afr., As., Am., Grl., A. S.

Amphora cymbelloides Grun. Cl. Syn., II, 136; A. S. Atl., Tab. XXVI, figs. 61—62 (A. angusta var. *glaberrima*).

Skálholtsvik (N.W.), H. Js.

Area: Eur., Afr., As., Am.

Mastogloia Thwaites 1898. Cl. Syn., II, 142.

Mastogloia elliptica Ag. Cl. Syn., II, 152; V. H. Syn., Tab. IV, fig. 19 (M. Dansei var. *ell.*).

Reykjavik (S.W.), C. H. O., Öndverðarnes (S.W.), H. Js., Búðir (S.W.), H. Js.

Area: Eur., Am.

Mastogloia elliptica Ag. var. *Dansei* Thw. Cl. Syn., l. c.; V. H. Syn., l. c., fig. 18 (M. Dansei).

Area: Eur., Aust.

Mastogloia exigua Lewis. Cl. Syn., II, 151; V. H. Trt., Tab. II, fig. 63.

Dyrafjörður (N.W.), C. H. O.

Area: Ubiquist, A. S.

Monoraphideæ

Achnantheæ Cl. 1895. Cl. Syn. II, 163.

Rhoicosphenia Grunow 1860. Cl. Syn., II, 165.

Rhoicosphenia curvata Ktz. Cl. Syn., II, 165; V. H. Trt., Tab. VII, fig. 319.

143 samples (S. 17, S.W. 74, N.W. 16, N. 27, E. 7, S. L. 2).

Area: Ubiquist, Grl., A. S.

Cocconeis (Ehr. 1835) Grun. 1868. Cl. Syn., II, 168.

Subgenus *Cocconeis* Cleve 1895. Cl. Syn., II, 168.

Cocconeis grata A. S. Cl. Syn., II, 172; Per. D. mar., Tab. III, figg. 6—7.

12 samples (S. 1, S.W. 10, N. 1).

Area: Eur., Am.

Cocconeis levis sp. nov. Tab. nost., fig. 11, a, b.

Hypotheca: Long.: 23μ , lat.: 10μ , striis inconspicuis.

Valva elliptica: Raphe ægre perspicienda, area hyalina angustissima cincta.

Epitheca(?): Long.: 16μ , lat.: 7μ .

Valva forma Hypothecæ. Raphe deest. Striis in margine modo difficillime perspicendis.

Skagafjörður (N.), Grld.

This small species offers very few marks for identification. I think my fig. b, in spite of its smaller size, may represent the epitheca. Both valves occur in the same slide. This species somewhat resembles the form delineated in A. S. Atl., tab. CXCIII, fig. 2, which Cleve refers to *Coc. placentula*.

Cocconeis Scutellum Ehr. var. *genuina* Cl. Cl. Syn., II, 170; V. H. Trt., Tab. VIII, fig. 338.

160 samples (S. 18, S.W. 74, N.W. 15, N. 38, E. 15).

Area: Ubiquist, Grl., A. S.

Cocconeis Scutellum Ehr. var. *ornata* Grun. Cl. Syn.; l. c., V. H. Syn., Tab. XXIX, figs. 6—7.

9 samples (S. 1, S.W. 5, N. 3).

Area: Eur., A. S.

Cocconeis Scutellum Ehr. var. *parva* Grun. Cl. Syn., l. c., V. H. Trt., Tab. VIII, fig. 339.

8 samples (S. 2, S.W. 6),

Area: Eur., Am., A. S.

Cocconeis Scutellum Ehr. var. *stauroneiformis* W. Sm. Cl. Syn., I. c., V. H. Syn., Tab. XXIX, figs. 10—11.

14 samples (S. 3, S.W. 7, N.W. 1, N. 3).

Area: Eur., Am., Aust., Grl., A. S.

Subgenus *Eucoconeis* Cleve 1895. Cl. Syn., II, 173.

Cocconeis molesta (Ktz.) Grun. var. *crucifera* Grun. Cl. Syn., II, 174; A. S. Atl., Tab. CXCI, figs. 49—51.

Arnarfjörður (N. W.), Lb.

Area: Eur., Afr.

Cocconeis dirupta Greg. Cl. Syn., II, 175; V. H. Trt., Tab. VIII, fig. 343.

28 samples (S. 3, S.W. 16, N.W. 1, N. 2, E. 6).

Area: Ubiquist, Grl., A. S.

Cocconeis dirupta Greg. var. *decipiens* Cl. Cl. Syn., I. c., Cl. A. S., Tab. I, fig. 6 & Tab. II, fig. 11 a (*C. arctica*).

Vattarnes (E.), H. Js.

Area: Eur., As., Am., Grl., A. S.

Cocconeis dirupta Greg. var. *Sigma* Pant. Cl. Syn., II, 176; A. S. Atl., Tab. CXCVIII, fig. 10 (*C. sigmoradians*) & figs. 22—24 (*C. Oculus Cati*).

4 samples (S. 1, S.W. 2, E. 1).

Area: As., Am., Grl., A. S.

Cocconeis pseudomarginata Grun. Cl. Syn., II, 178; V. Trt., Tab. XXIX, fig. 824.

Vestmannaeyjar (S.), H. Js.

Area: Ubiquist, Grl., A. S.

Subgenus *Pleuroneis* Cleve 1895. Cl. Syn., II, 181.

Cocconeis britannica Nägeli. Cl. Syn., II, 181; V. H. Syn., Tab. XXX, figs. 1—2.

Hrisey (N.), H. Js.

Area: Eur., Am.

Cocconeis costata Greg. Cl. Syn., II, 182; V. H. Trt., Tab. XXIX, fig. 816.

119 samples (S. 10, S.W. 49, N.W. 18, N. 28, E. 14).

Area: Eur., Am., Aust., Grl., A. S.

Subgenus *Heteroneis* Cleve 1895. Cl. Syn., II, 182.

Cocconeis Pelta A. S. Cl. Syn., II, 184; A. S. Atl., Tab. CXCI, fig. 6.

Arnarfjörður (N. W.), Lb.

Area: Eur.

Achnanthes Bory.

Subgenus *Microneis* Cleve 1895. Cl. Syn., II, 187.

Achnanthes Hauckiana Grun. Cl. Syn., II, 190; V. H. Syn., Tab. XXVII, figs. 14—15.

Isafjörður (N.W.), C. H. O.

Area: Eur., Am., Aust.

Achnanthes islandica sp. nov. Tab. nost., fig. 12.

Long.: $24\ \mu$, lat: $9.5\ \mu$, str., utrisque in valvis, 12 in $10\ \mu$, punctatis.

Epitheca: Valva elliptice-lanceolata, area apicali angusta, media in valva posita.

Hypotheca: Valva elliptica. Striis ut in epitheca, parallelis, apices versus tamen leniter radiantibus, media in parte valvæ fasciam transapicalem satis latam relinquentibus.

Stykkishólmur (S.W.) H. Js.

In am not sure of the place of this small form within the Achnantheae. It scarcely belongs to the form-series of Achn. brevipes. Perhaps it is more closely allied to Achn. hungarica (Cl. Syn., II, 190. V. H. Trt., tab. VIII, fig. 328). It has been found in a sample, also containing fresh-water species, an occurrence not rare in the samples from the coasts of Iceland, examined by me.

Subgenus *Achnanthidium* (Ktz. 1844) Heib. 1863. Cl. Syn., II, 191.

Achnanthes brevipes Ag. var. *typica* Cl. Cl. Syn., II, 193; V. H. Trt., Tab. VIII, fig. 324.

24 samples (S. 4, S.W. 7, N.W. 4, N. 7, E. 2),

Area: Ubiquist, Grl., A. S.

Achnanthes brevipes Ag. var. *intermedia* Ktz. Cl. Syn., II, l. c.; V. H. Trt., Tab. VIII, fig. 325. (A. subsessilis.)

29 samples (S. 5, S.W. 7, N.W. 3, N. 11, E. 3).

Area: Ubiquist, Grl., A. S.

Achnanthes brevipes Ag. var. *linearis* Øst. Øst. K. D., 330, Tab. II, fig. 9.

Reykjavik (S.W.), H. Js.

Area: Grl.

Achnanthes brevipes Ag. var. *parvula* Ktz. Cl. Syn., II, l. c.; V. H. Trt., Tab. VIII, fig. 326.

30 samples (S. 2, S.W. 19, N.W. 2, N. 4, E. 3).

Area: Eur., Am., Grl.

In a sample from Kolbeinsá (N.) H. Js. I have found an Achn. brev. typica, having only $5\frac{1}{2}$ str. in $10\ \mu$, an uncommonly wide striation, and in a sample from the same locality (H. Js.) I have also found the short

and broad form of *Achn. brev.* mentioned in my »Kyst Diat. fra Grønland«, delineated in table II, fig. 13.

Achnanthes Groenlandica Cl. Cl. Syn., II, 195; Cl. A. D., Tab. IV, fig. 23.

Hvammssfjörður (S.W.), H. Js.

Area: Am., Grl., A. S.

Subgenus *Achnanthes* (Bory). Cl. Syn. II, 195.

Achnanthes longipes C. Ag. Cl. Syn., II, 195; V. H. Trt., Tab. VIII, fig. 323.

Prestbakki (N.), H. Js.

Area: Eur., Afr., As., Am., Grl.

Kalyptoraphideæ

Eschatoraphideæ

Surirellâ Turpin 1827. V. H. Trt., 368.

Surirella fastuosa Ehr. V. H. Trt., 372, Tab. XIII, fig. 583.

Vestmannaeyjar (S.), H. Js., Reykjavik (S.W.), H. Js., Isafjörður (N.W.), H. Js.

Area: Ubiquist.

Campylodiscus Ehr. 1841. V. H. Trt., 375.

Campylodiscus angularis Greg. V. H. Trt., 378, Tab. XXXV, fig. 909.

Viðey (S.W.), H. Js.

Area: Eur., Grl., A. S.

Campylodiscus biangulatus Grev. Per. D. mar., 242, Tab. LV, fig. 9.

Isafjörður (N.W.), C. H. O.

Area: Eur., Afr., As., Aust., Grl.

Campylodiscus fluminensis Grun. Per. D. mar., 244, Tab. LV, fig. 11.

Vestmannaeyjar (S.), H. Js., Reykjavik (S.W.), H. Js.

Area: Eur.

Campylodiscus Samoensis Grun. Per. D. mar., 241, Tab. LIV, figs. 6—8.

Skálholtsvík (N.W.), H. Js.

Area: Eur., Am., Aust.

Campylodiscus Thureti Bréb. V. H. Trt., 378, Tab. XIV, fig. 595.

Reykjavik (S.W.), H. Js., Seydisfjörður (E.), H. Js.

Area: Eur., Afr., As., Am., Grl.

Tropidoraphideæ.**Hantzschia** Grun. 1877. V. H. Trt., 380.**Hantzschia marina** (Donk.) Grun. V. H. Trt., 382, Tab. XV, fig. 489 b.

Höfði (N.), H. Js.

Area: Eur., Am., Grl.

Hantzschia virgata (Roper) Grun. V. H. Trt., 381, Tab. XV, fig. 488 b.

Dyrafjörður (N.W.), C. H. O.

Area: Eur., Afr., As., Am., A. S.

Nitzschia (Hassall 1845; W. Smith), Grun. Ch. emend. 1880. V. H. Trt., 382. *Tryblionella* W. Smith partim, Grun. 1880. V. H. Trt., 384.**Nitzschia Tryblionella** Hantzsch var. *littoralis* Grun. V. H. Trt., 385, Tab. XV, fig. 496.

Stykkishólmur (S.W.), H. Js.

Area: Eur., Am.

Apiculatæ Grun. 1880. V. H. Trt., 387.**Nitzschia acuminata** (W. Sm.) Grun. V. H. Trt., 388, Tab. XV, fig. 506.

Kolbeinsá (N.), H. Js., Grjótnes (N.), C. H. O., Brimnes (E.), H. Js.

Area: Eur., As., Am.

Nitzschia apiculata (Greg.) Grun. V. H. Trt., 387, Tab. XV, fig. 505.

6 samples (S. 1, S.W. 3, N. 2).

Area: Eur., As., Am., Grl., A. S.

Nitzschia marginulata Grun. Per. D. mar., 270, Tab. LXX, figs. 14—17.

5 samples (S.W. 2, N.W. 1, N. 2).

Area: Eur., Am., Aust., A. S.

As regards var. *subconstricta*, which I have found together with the main species, I agree with Peragallo l.c. when he says: "... ses variétés constricta et subconstricta ne sont pas acceptables. la constriction médiane étant essentiellement variable chez cette espèce très polymorphe."

Bilobatæ Grun. 1880. V. H. Trt., 389.**Nitzschia bilobata** W. Sm. V. H. Trt., 389, Tab. XV, fig. 512.

Stykkishólmur (S.W.), H. Js., Öndverðarnes (S.W.), H. Js., Isafjörður (N.W.), H. Js.

Area: Ubiquist, Grl.

Nitzschia bilobata W. Sm. var. *minor* Grun. V. H. Trt., 390, Tab. XV, fig. 513.

Isafjörður (N.W.), C. H. O.

Area: Cum typo (De Ton. Syll., II, 514).

Bacillaria Grun. 1880. V. H. Trt., 392.

Nitzschia paradoxa (Gmel.) Grun. V. H. Trt., 392, Tab. XVI, fig. 518.

Isaffjörður (N. W.), C. H. O.

Area: Eur., Afr., As., Am., Grl., A. S.

Nitzschia socialis Greg. Cl. & Grun. A. D., 85: V. H. Syn., Tab. LXI, fig. 8.

9 samples (S. 1, S. W. 3, N. W. 1, N. 3, E. 1).

Area: Eur., Afr., As., Am., Grl., A. S.

Vivaces Grun. 1880. V. H. Trt., 392.

Nitzschia islandica sp. nov. Tab. nost., fig. 13.

Long.: 94 μ , lat.: 12 μ , str. 19—20 in 10 μ , punct. car. 6,5 in 10 μ .

Valva late-lineari, media in parte leniter contracta, apices apiculatos versus attenuata. Carina admodum excentrica, sinuata.

Kolbeinsá (N.), H. Js.

I think the somewhat excentric keel qualifies this species to be classed under »Vivaces«. See also fig. 522 of *N. vivax* in Per. D. mar., tab. XVI.

Spathulatæ Grun. 1880. V. H. Trt., 393.

Nitzschia angularis W. Sm. V. H. Trt., 393, Tab. XVI, fig. 521.

10 samples (S. 2, S. W. 6, N. W. 1 N. 1).

Area: Eur., As., Am., Aust., Grl., A. S.

Nitzschia angularis W. Sm. var. *affinis* Grun. V. H. Trt. l. c., Tab. l. c., fig. 522.

4 samples (S. 1, S. W. 2, E. 1).

Area: Eur., Grl.

Dissipatæ Grun. 1880. V. H. Trt. 394.

Nitzschia dissipata (Ktz.) Grun. var. *Acula* Hantzsch. V. H. Trt., 395, Tab. XVI, fig. 527. (N. v. d. acuta).

Isaffjörður (N. W.), C. H. O., Prestbakki (N.), H. Js.

Area: Eur., Aust.

I have retained the name »Acula«, as this undoubtedly is the correct one. This form is, as far as I know, first described in Cl. & Gr. A. D. (1880), pag. 90 under the name of *Nitzschia Acula* Hantzsch. It is found under the same name as a var. of *N. dissipata* in V. H. Syn. (1885), pag. 178, and in the text to tab. LXIII, fig. 4. But »Acula« is everywhere altered to »acuta« in De Toni Syll. (1892) pag. 527, V. H. Trt. (1899), pag. 395 and in Per. D. mar. (1897—1908), pag. 281. If »Acuta«, by Hantzsch or Grunow, has been considered an error in writing, I do not know, but »Acula« is however, perhaps not a particularly good Latin word, meaning »a small needle« (see Arnesen: »Ny latinsk Ordbog«, Kjøbenhavn 1848, pag. 56) but the term is very apposite to the variety in question.

Sigmata Grun. 1880. V. H. Trt., 396.

Nitzschia Sigma W. Sm. V. H. Trt., 396, Tab. XVI, fig. 531.

12 samples (S. 1, S.W. 8, N. 1, E. 2).

Area: Ubiquist, Grl., A. S.

Nitzschia Sigma W. Sm. var. *rigida* (Ktz.) Grun. V. H. Trt., l. c., fig. 533.

Búðir (S.W.), H. Js.

Area: Eur., Afr.

Lineares Grun. 1880. V. H. Trt., 398.

Nitzschia vitrea Norman var. *Salinarum* Grun. V. H. Trt., 399, Tab. XVI, fig. 546.

Njarðvík (S.W.), C. H. O.

Area: Eur.

Lanceolatae Grun. 1880. V. H. Trt., 400.

Nitzschia lanceolata W. Sm. V. H. Trt., 400, Tab. XVII, fig. 548.

Reykjavík (S.W.), B. S.

Rhopalodia O. Müller 1895. V. H. Trt., 307.

Rhopalodia Musculus (Ktz.) O. M. V. H. Trt., 297, Tab. IX, fig. 359. (Epithemia Musc.)

Steingrímsfjörður (N. 3 samples), H. Js.

Arraphideæ

Synedra Ehr. 1831. V. H. Trt., 307.

Synedra affinis Ktz. V. H. Trt., 314; Per. D. mar., 318.

I have found *Synedra affinis* with variants as delineated in V. H. Syn., tab. XLI, in Per. D. mar., tab. LXXX, and in A. S. Atl., tab. CCCIV, in all in 184 samples (S. 13, S.W. 77, N.W. 27, N. 50, E. 17).

Of the numerous variants, difficult to distinguish from each other, I have noted the following:

Synedra affinis var. *gracilis* Grun. V. H. Syn., Tab. XLI, fig. 15 B.

Area: Eur., Grl.

Synedra affinis var. *fasciculata* Ktz. V. H. Syn., l. c., fig. 15.

Area: Eur., As., Grl., A. S.

Synedra affinis var. *lancettula* Grun. V. H. Syn., l. c., fig. 28.

Area: Am., Grl.

Synedra affinis var. *parva* Ktz. V. H. Syn., l. c., fig. 23.

Area: Eur., Afr., Aust., Grl., A. S.

Synedra affinis var. *rupicola* Grun. V. H. Syn., l. c., fig. 27.

Area: Eur., Grl.

Synedra affinis var. *tabulata* Ktz. V. H. Syn., l. c., fig. 9 A.

Area: Eur., Aust., Grl.

Synedra affinis var. *typica* Ktz. A. S. Atl., Tab. CCCV, figs. 6—12.

Area: Ubiquist, Grl., A. S.

Amongst these, the most frequently occurring species are:

typica: 106 samples (S. 17, S.W. 48, N.W. 20, N. 11, E. 10).

tabulata: 44 samples (S. 4, S.W. 20, N.W. 6, N. 13, E. 1).

gracilis: 41 samples (S. 2, S.W. 12, N.W. 7, N. 17, E. 3).

parva: 14 samples (S. 2, S.W. 5, N.W. 3, N. 2, E. 2).

Synedra crystallina (Lyngb.) Ktz. V. H. Trt., 315, Tab. X, fig. 435.

Vestmannaeyjar (S.), H. Js.

Area: Eur., Afr., As., A. S.

Synedra curvata sp. nov. Tab. nost., fig. 14.

Long.: 104—178 μ , lat.: media in valva, 3,6—5 μ , str. 19—20 in 10 μ .

Valva lineari, apices versus leniter attenuata, curvata. Striis marginalibus.

Isafjörður (N.W.), C. H. O.

Owing to its marginally situated striae, this species is probably most closely allied to the form-series of *Synedra affinis*. It has no connection with *Syn. curvula* Ktz. Bacil., 65, tab. XV, fig. II (a fresh-water species from Nordhausen in Saxony).

Synedra Gailloni Ehr. V. H. Trt., 312, Tab. X, fig. 424.

16 samples (S. 1, S.W. 15).

Area: Eur., Afr., As., Am.

In a sample from Melvik, near Reykjanes (S.W.), C. H. O., I have found a *Synedra*, which corresponds well with *Syn. capensis* Grun. V. H. Syn., tab. XLII, fig. I, a form closely allied to *Syn. Gail*.

Synedra Henedyana Greg. V. H. Trt., 317, Tab. X, fig. 438.

Vattarnes (E.), H. Js.

Area: Eur.

Synedra investiens W. Sm. V. H. Trt., 313, Tab. X, fig. 425.

62 samples (S. 17, S.W. 25, N.W. 5, N. 8, E. 7).

Area: Eur., Grl.

Synedra kamtschatica Grun. Cl. & Gr. A. D., 106; Øst. Østg. mar., Tab. VII, fig. 85.

8 samples (S.W. 1, N.W. 1, N. 4, E. 2).

Area: Grl., A. S.

Synedra provincialis Grun. Trans. Mic. Soc. XVIII, 166; V. H. Syn., Tab. XL., fig. 8.

Reykjavik (S. W.), Grld.

Area: Eur.

The species found by me is a forma minor (long. $54\ \mu$). The length of the typical Syn. provinc. is given by Grunow as: $65-110\ \mu$.

Synedra pulchella Ktz. V. H. Trt., 309, Tab. X, fig. 402.

15 samples (S. 3, S. W. 2, N. W. 5, N. 4, E. 1).

Area: Eur., As., Am., Grl., A. S.

Thalassionema Grun. V. H. Trt., 319.

Thalassionema nitzschioides Grun. Per. D. mar., 320, Tab. LXXXI, figs. 17—18.

Eyrarbakki (S.), H. Js.

Area: Eur., Am.

Thalassiothrix Cl. & Grun. 1880. V. H. Trt., 321.

Thalassiothrix Frauenfeldi Grun. Per. D. mar., 321, Tab. LXXXI, fig. 15.

Prestbakki (N.), H. Js.

Area: Eur., As., Grl.

Fragilaria Lyngbye 1819. V. H. Trt., 323.

Fragilaria hyalina (Ktz.) Grun. V. H. Trt., 324, Tab. XI, fig. 443.

5 samples (S. W. 2, E. 3).

Area: Eur., Afr., As.

Fragilaria striatula Lyngb. V. H. Trt., 324; Per. D. mar., Tab. LXXXI, fig. 5.

82 samples (S. 12, S. W. 30, N. W. 5, N. 13, E. 20, S. L. 2).

Area: Eur., Am., Aust., Grl., A. S.

Fragilaria vitrea Ktz. Per. D. mar., 326, Tab. LXXXI, fig. 2.

28 samples (S. 3, S. W. 6, N. W. 5, N. 11, E. 3).

Area: Eur., Am.

Var. minima Per. D. mar. l. c., fig. 3, I have found interspersed among the main-species.

Rhaphoneis Ehr. 1844. V. H. Trt., 329.

Rhaphoneis amphiceros Ehr. var. *rhombica* Grun. V. H. Trt., 330, Tab. X, fig. 395.

Búðir (S. W.), H. Js.

Area: Ubiquist.

Dimeregramma Ralfs 1861. V. H. Trt., 335.

Dimeregramma minus (Greg.) Ralfs var. *nanum* Greg. V. H. Trt., 336, Tab. X, fig. 393.

Broddanes (N.), H. Js.

Area: Eur.

Plagiogramma Grev. 1859. V. H. Trt., 337.

Plagiogramma Gregorianum Grev. V. H. Trt., 338, Tab. X, fig. 390.

Kolbeinsá (N.), H. Js., Bildudalur (N.W.), H. Js.

Area: Ubiquist, Grl., A. S.

Licmophora Agardh. 1827. V. H. Trt., 341.

Licmophora anglica (Ktz.) Grun. V. H. Trt., 343, Tab. XI, fig. 458.

32 samples (S. 1, S.W. 14, N. 8, E. 9).

Area: Eur., Afr., As., Am., Grl.

Licmophora anglica (Ktz.) forma *elongata* V. H. Syn., Tab. XLVI, fig. 15.

6 samples (S.W. 1, N. 1, E. 4).

Area: De Toni Syll. pag. 733: »cum specie».

Licmophora anglica Jürgensi Ag. V. H. Trt., 343, Tab. XXXI, fig. 850.

4 samples (S.W. 1, N. 2, E. 1).

Area: Eur., Grl., A. S.

Licmophora Oedipus (Ktz.) Grun. Per. D. mar., 356 (L. Jürgensi var. *Oedipus*); V. H. Syn., Tab. XLVII, figs. 2—3.

44 samples (S. 5, S.W. 12, N.W. 5, N. 11, E. 11).

Area: Eur., As.

Licmophora Oedipus forma *elongata*. V. H. Syn., Tab. XLVII, fig. 1.

Stykkishólmur (S.W.), H. Js., Höfði (N.), H. Js.

Area: Eur.

Licmophora paradoxa (Lyngb.) Ag. V. H. Trt., 344, Tab. XXXI, fig. 855.

32 samples (S.W. 14, N.W. 7, N. 8, E. 3).

Area: Eur., Afr., Am., Grl.

Grammatophora Ehr. 1839. Per. D. mar., 352.

Grammatophora angulosa Ehr. 1839. Per. D. mar., 357, Tab. LXXXVIII, figs. 11—13.

60 samples (S. 16, S.W. 34, N.W. 4, N. 4, E. 2).

Area: Ubiquist.

Grammatophora angulosa Ehr. var. *hamulifera* Ktz. Per. l. c., 358, Tab. l. c., figs. 16—17.

19 samples (S. 5, S.W. 10, N. 1, E. 3).

Area: Eur., As., Am.

Grammatophora angulosa Ehr. var. *islandica* Ehr. Per. l. c., 358, Tab. l. c., figs. 14—15.

125 samples (S. 23, S.W. 61, N.W. 10, N. 21, E. 10).

Area: Eur., Am., Grl., A. S.

Grammatophora arcuata Ehr. Grun. Øst. Diat., 1862, 420, Tab. XI, fig. 7.

21 samples (S. 7, S.W. 5, N.W. 2, N. 6, E. 1).

Area: Aust., Grl., A. S.

Grammatophora marina (Lyngb.) Ktz. P. D. mar., 353, Tab. LXXXVII, figs. 6—8.

155 samples (S. 31, S.W. 98, N.W. 11, N. 12, E. 3).

Area: Ubiquist.

Grammatophora oceanica Ehr. var. *macilenta* W. Sm. Per. D. mar., 355, Tab. LXXXVII, figs. 14—17.

28 samples (S. 3, S.W. 17, N.W. 4, N. 4).

Area: Eur.

Grammatophora oceanica forma *minuscula* Per. Per. l. c., 355, Tab. l. c., fig. 13.

66 samples (S. 19, S.W. 38, N.W. 4, N. 5).

Area: Eur.

In a sample from Skerjafjörður (S.W.), H. Js. I have found a curved Gram. oc. macil., of which I have given a figure in tab. nost. fig. 15. It has the dimensions: long. 73 μ , lat. 6.5 μ .

Grammatophora serpentina Ehr. Per. D. mar., 356, Tab. LXXXVIII, figs. 2—5.

Vestmannaeyjar (S., 2 samples), H. Js.

Area: Ubiquist.

Rhabdonema Ktz. 1844. V. H. Trt., 360.

Rhabdonema adriaticum Ktz. V. H. Trt., 360. Tab. XII, fig. 486 a.

Vestmannaeyjar (S., 3 samples), H. Js.

Area: Ubiquist.

Rhabdonema arcuatum (Ag.) Ktz. V. H. Trt., 360, Tab. XII, fig. 487 a.

303 samples (S. 38, S.W. 126, N.W. 21, N. 77, E. 36, S. L. 5).

Area: Ubiquist, Grl., A. S.

Rhabdonema arcuatum is a form which, as regards its outline, is variable, and in the samples examined by me, it appears with recti-linear as well as with more or less curved sides (see Cleve's var. *ventricosum* in Cl. Arct. S., 24, tab. IV, fig. 21). The curved species may perhaps be identical with *Rhabd. Crozieri* Grun. Concerning this see Mann, Albat. 322 under *Tessela catena* Ehr.

Rhabdonema minutum Ktz. V. H. Trt., 361, Tab. XII, fig. 488 a.

231 samples (S. 34, S. W. 113, N. W. 27, N. 42, E. 15).

Area: Ubiquist, Grl., A. S.

Rhabdonema robustum Grun. Grun. Øst. Diat., 422; A. S. Atl., Tab. CCXXI, figs. 17—23.

Vestmannaeyjar (S.), H. Js.

Area: Am.

Striatella Agardh 1832. V. H. Trt., 362.

Striatella delicatula (Ktz.) Grun. V. H. Trt., 363, Tab. XII, fig. 483 a.

Skógarnes (S. W.), H. Js.

Area: Eur., Afr., As., Am.

CENTRICÆ

Rhizosolenia (Ehr. Brightw.) Per. em. 1892. Gr. N. P., 46.

Rhizosolenia hebetata Bail. f. *semispina* Hensen. Gr. N. P., 55, fig. 67 b.

Einarslón (N.), H. Js.

Area: »Ozeanische Form, besonders im nordwestlichen Teile des Gebietes einheimisch«. (Gr. l. c.).

Chætoceras Ehr. 1844. Gr. N. P., 58.

Chætoceras boreale Bail. Gr. N. P., 73, fig. 87.

Arnarnes (N.) H. Js.

Area: Ubiquist, Grl., A. S.

Chætoceras Diadema Ehr. Gr. N. P., 84, fig. 102 b.

5 samples (S. W. 2, N. W. 1, N. 2).

Area: Eur., As., Am., Grl., A. S.

Only spores have been found.

Chætoceras furcellatum Bail. Gr. N. P., 95, fig. 121.

Reykjavik (S. W.), H. Js.

Area: Eur., Grl., A. S.

Only spores have been found.

Chætoceras Ingolfianum Ostenf. Gr. N. P., 90, fig. 115.

Háfranes (E.), H. Js.

Area: Eur.

Only spores have been found.

Thalassiosira Cl. 1872. Gr. N. P., 16.

Thalassiosira gravida Cl. Gr. N. P., 18, fig. 12; spore, A. S. Atl., Tab. LVIII, fig. 44 (*Coscinodiscus subglobosus*).

7 samples (all S.W.), H. Js., Grld., C. H. O.

Area: Eur., Am., Grl., A. S.

Only spores have been found.

Melosira Agardh 1824. V. H. Trt. 438.

Melosira nummuloides (Bory) Ag. V. H. Trt. 440, Tab. XVIII, fig. 608.

26 samples (S. 3, S.W. 9, N.W. 4, N. 7, E. 3).

Area: Ubiquist, Grl., A. S.

Melosira sulcata (Ehr.) Ktz. V. H. Trt., 444, Tab. XIX, fig. 624.

81 samples (S. 5, S.W. 61, N.W. 9, N. 6).

Area: Eur., Afr., As., Am., Grl., A. S.

Melosira sulcata f. *radiata*. Grun. Fz. J. L., 42, Tab. V, fig. 35.

8 samples (S.W. 6, N.W. 1, N. 1).

Area: Eur., A. S.

Podosira Ehr. 1840. V. H. Trt., 447.

Podosira hormoides (Mont.) Cl. & Gr. A. D., 118; A. S. N. S. D., Tab. III, fig. 40.

156 samples (S. 24, S.W. 79, N.W. 19, N. 17, E. 14, S. L. 3).

Area: Eur., Am., Grl.

In several of the samples examined by me *Podos. horm.* occurs with a diameter of up to 70μ and of a very fine structure. For this reason it may perhaps be considered as a forma major of *Podos. horm.* var. *glacialis* Grun., see Fz. J. L., 56, tab. V, fig. 32. I have found it with the more distinct punctuations indicated in the figure, as well as without these.

Hyalodiscus Ehr. 1854. V. H. Trt., 448.

Hyalodiscus subtilis Bail. Per. D. mar., 443, Tab. CXIX, fig. 7.

7 samples (S.W. 1, N. 3, E. 3).

Area: Eur., Afr., As., Am., Grl., A. S.

Hyalodiscus subtilis Bail. var. *scoticus* (Ktz.) Grun. Per. l. c. 443, Tab. l. c., fig. 8.

209 samples (S. 28, S.W. 110, N.W. 24, N. 39, E. 7, S. L. 1).

Area: Eur., Am., Aust., Grl., A. S.

Isthmia Ag. 1830. Per. D. mar., 375.

Isthmia nervosa Ktz. Per. D. mar., 375, Tab. XCI.

64 samples (S. 20, S.W. 24, N.W. 3, N. 7, E. 7, S. L. 3).

Area: Eur., Am., Grl., A. S.

Biddulphia Gray 1831. V. H. Trt. 466.

Biddulphia antediluviana (Ehr.) H. V. H. V. H. Trt., 475, Tab. XXI, fig. 642.

Vestmannaeyjar (S.), H. Js.

Area: Eur., Afr., Am.

Biddulphia aurita (Lyngb.) Bréb. V. H. Trt., 471, Tab. XX, fig. 631.

180 samples (S. 14, S. W. 83, N. W. 29, N. 34, E. 17, S. L. 3).

Area: Eur., Afr., As., Am., Grl., A. S.

Biddulphia (Odontella) obtusa Ktz. Per. D. mar., 381; V. H. Syn., Tab. C, figs. 11—14.

4 samples (S. W. 2, N. W. 1, E. 1).

Area: Ubiquist.

Trigonium Cl. 1867. Per. D. mar., 377.

Trigonium arcticum (Bright.) Cl. Per. D. mar., 379. Brightv. Tric., Tab. IV, fig. 11 (Triceratium arct.).

Flatey by Husavik (N.), Hörr.

Area: Eur., Afr., Am., Grl., A. S.

Actinoptychus Ehr. 1838. V. H. Trt., 493.

Actinoptychus undulatus (Ehr.) Ralfs. V. H. Trt., 496, Tab. XXII, fig. 648.

5 samples (all S. W.), Grld., H. Js.

Area: Ubiquist, Grl.

Actinocyclus Ehr. 1840. V. H. Trt., 522.

Actinocyclus Barkleyi (Ehr.) Grun. Ratt. Actinoc., 158; V. H. Syn., Tab. CXXIV, fig. 12.

Vestmannaeyjar (S.), H. Js.

Area: Am., Aust.

Actinocyclus crassus H. V. H. V. H. Trt., 523, Tab. XXIII, fig. 660.

Vestmannaeyjar (S.), H. Js., Reykjavik (S. W.), H. Js.

Area: Ubiquist.

Actinocyclus Ralfsi (W. Sm.) Ralfs. Per. D. mar., 414, Tab. CXIII, fig. 2.

Vestmannaeyjar (S.), H. Js., Hafnafjörður (S. W.), H. Js., Reykjavik (S. W.), H. Js.

Area: Ubiquist, Grl.

Actinocyclus subtilis (Greg.) Ralfs. V. H. Trt., 524, Tab. XXIII, fig. 661.

Melvik (S. W.), C. H. O.

Area: Ubiquist.

Coscinodiscus Ehr. 1838. V. H. Trt., 525.

Coscinodiscus excentricus Ehr. V. H. Trt., 531, Tab. XXIII, fig. 666

Steingrimsfjörður (N.), H. Js.

Area: Ubiquist, Grl., A. S.

TABULAR SURVEY

	Universal distribution							Distribution in the different parts of the coasts of Iceland				
	Eur.	Afr.	As.	Am.	Aust.	Grl.	A. S.	S.	S.W.	N.W.	N.	E.
Achnanthes												
— brevipes	x	x	x	x	x	x	x	x	x	x	x	x
— — linearis						x			x			
— — intermedia	x	x	x	x	x	x	x	x	x	x	x	x
— — parvula	x			x		x		x	x	x	x	x
— — var.						x			x			
— groenlandica				x		x	x		x			
— Hauckiana	x			x	x					x		
— longipes	x	x	x	x		x				x		
Actinocyclus												
— Barkleyi				x	x			x				
— crassus	x	x	x	x	x			x	x			
— Ralfsi	x	x	x	x	x	x		x	x			
— subtilis	x	x	x	x	x				x			
Actinoptychus												
— undulatus	x	x	x	x	x	x			x			
Amphipleura												
— rutilans	x	x	x			x			x	x	x	
Amphora												
— angusta	x	x	x	x		x	x		x		x	
— crassa	x	x	x	x		x	x	x			x	
— cymbelloides	x	x	x	x							x	
— exigua	x			x	x				x			
— lævis	x		x				x		x			
— lineolata	x		x	x			x	x	x	x		
— marina	x		x	x		x	x	x	x	x	x	x
— Proteus	x	x	x	x	x	x	x	x	x	x	x	x
— — contigua	x		x		x			x	x	x		
— Pusio	x				x	x		x				
— robusta	x		x		x		x			x		
— Terroris	x		x	x	x	x	x	x	x	x	x	x
Biddulphia												
— antediluviana	x	x		x				x				
— aurita	x	x	x			x	x	x	x	x	x	x
— obtusa	x	x	x	x	x					x		
Caloneis												
— brevis	x	x	x	x	x	x	x		x	x		
	26	16	21	23	16	18	13	15	21	15	11	7

		Universal distribution							Distribution in the different parts of the coasts of Iceland				
		Eur.	Afr.	As.	Am.	Aust.	Gr.	A. S.	S.	S.W.	N.W.	N.	I.
31	(<i>Caloneis brevis</i>) <i>distoma</i>			x				x			x		
32	— <i>formosa</i>	x	x	x	x	x	x			x	x		
33	— <i>Liber genuina</i>	x	x	x	x	x	x	x	x	x	x		
34	— — <i>elongata</i>	x	x	x	x		x	x		x			
35	— — <i>linearis</i>	x	x	x	x					x	x	x	
Campylodiscus													
36	— <i>angularis</i>	x					x	x		x			
37	— <i>biangulatus</i>	x	x	x		x	x				x		
38	— <i>fluminensis</i>	x							x	x			
39	— <i>Samoensis</i>	x		x		x						x	x
40	— <i>Thureti</i>	x	x	x	x		x			x			x
Chætoceras													
41	— <i>boreale</i>	x	x	x	x	x	x	x				x	
42	— <i>Diadema</i>	x		x	x		x	x		x	x	x	
43	— <i>furcellatum</i>	x					x	x		x		x	
44	— <i>Ingolfianum</i>	x											x
Cocconeis													
45	— <i>britannica</i>	x			x							x	
46	— <i>costata</i>	x			x	x	x	x	x	x	x	x	x
47	— <i>dirupta</i>	x	x	x	x	x	x	x	x	x	x	x	x
48	— — <i>decipiens</i>	x		x	x		x	x	x				x
49	— — <i>Sigma</i>			x	x		x	x	x	x			x
50	— <i>grata</i>	x			x				x	x		x	
51	— <i>molesta</i>	x	x								x		
52	— <i>Pelta</i>	x									x		
53	— <i>pseudomarginata</i>	x	x	x	x	x	x	x	x				
54	— <i>Scutellum</i>	x	x	x	x	x	x	x	x	x	x	x	x
55	— — <i>ornata</i>	x						x	x	x		x	
56	— — <i>parva</i>	x			x			x	x	x			
57	— — <i>stauroneiformis</i>	x			x	x	x	x	x	x	x	x	
Coscinodiscus													
58	— <i>excentricus</i>	x	x	x	x	x	x	x			x		
Dimeregramma													
59	— <i>minus nanum</i>	x								x			
		27	12	16	18	11	17	17	12	18	13	12	8

		Universal distribution							Distribution in the different parts of the coasts of Iceland				
		Eur.	Afr.	As.	Am.	Aust.	Grl.	A. S.	S.	S.W.	N.W.	N.	E.
Diploneis													
0	— <i>æstiva</i>	x	x	x	x			x		x	x		
1	— <i>bomboides media</i>	x					x	x		x			
2	— <i>chersonnensis</i>	x	x	x	x	x			x	x	x	x	
3	— <i>coffæiformis</i>	x		x	x		x					x	x
4	— <i>constricta</i>	x		x	x		x	x			x		
5	— <i>contigua Eudoxia</i>	x	x	x	x			x	x				
6	— <i>Crabro minuta</i>	x				x			x				
7	— <i>didyma</i>	x	x	x	x	x	x	x				x	
8	— <i>elliptica grandis</i>	x								x			
9	— <i>fusca subrectangularis</i>	x		x						x	x		
0	— <i>incurvata</i>	x	x		x			x	x	x	x	x	x
1	— <i>interrupta</i>	x	x	x	x	x	x	x		x	x	x	x
2	— <i>lineata</i>	x	x						x	x			
3	— <i>littoralis</i>	x	x	x	x	x	x	x		x	x		
4	— <i>major</i>	x	x	x	x	x	x		x				
5	— <i>Smithi</i>	x	x	x	x	x	x	x		x		x	
6	— <i>splendida</i>	x	x	x	x	x	x	x		x			
7	— <i>subcincta</i>	x	x		x		x	x		x	x	x	
Fragilaria													
8	— <i>hyalina</i>	x	x	x						x			x
9	— <i>striatula</i>	x			x	x	x	x	x	x	x	x	x
0	— <i>vitrea</i>	x			x				x	x	x	x	x
Gomphonema													
1	— <i>exiguum</i>	x		x			x		x	x	x	x	x
2	— <i>kamtschaticum</i>						x	x	x	x	x	x	x
Grammatophora													
3	— <i>angulosa</i>	x	x	x	x	x			x	x	x	x	x
4	— <i>hamulifera</i>	x		x	x				x	x		x	x
5	— <i>islandica</i>	x			x		x	x	x	x	x	x	x
6	— <i>arcuata</i>					x	x	x	x	x	x	x	x
7	— <i>marina</i>	x	x	x	x	x			x	x	x	x	x
8	— <i>oceanica macil.</i>	x					x		x	x	x	x	
9	— <i>minuta</i>	x							x	x	x	x	
0	— <i>serpentina</i>	x	x	x	x	x			x				
Hantzschia													
1	— <i>marina</i>	x			x		x					x	
2	— <i>virgata</i>	x	x	x	x			x			x		
		31	17	19	22	13	17	16	18	24	19	19	13

		Universal distribution							Distribution in the different parts of the coasts of Iceland				
		Eur.	Afr.	As.	Am.	Aust.	Gr.	A. S.	S.	S.W.	N.W.	N.	E.
Hyalodiscus													
93	— subtilis	x	x	x	x		x	x		x		x	x
94	— — scoticus	x			x	x	x	x	x	x	x	x	x
Isthmia													
95	— nervosa	x			x		x	x	x	x	x	x	x
Licmophora													
96	— anglica	x	x	x	x		x		x	x		x	x
97	— Jürgensi	x					x	x		x	x		x
98	— Oedipus	x		x					x	x	x	x	
99	— — elongata	x								x		x	
100	— paradoxa	x	x		x		x			x	x	x	x
Mastogloia													
101	— elliptica	x			x					x			
102	— — Dansei	x				x					x		
103	— exigua	x	x	x	x	x		x			x		
Melosira													
104	— nummuloides	x	x	x	x	x	x	x	x	x	x	x	x
105	— sulcata	x	x	x	x		x	x	x	x	x	x	
106	— — radiata	x						x		x	x	x	
Navicula													
107	— abrupta	x	x	x				x			x		
108	— Acus	x								x			
109	— ammophila flauatica	x								x			
110	— anglica subsalina	x										x	
111	— arenaria arcuata	x								x	x		
112	— avenacea	x	x	x		x	x	x		x	x	x	x
113	— Bolleana	x					x	x				x	
114	— bottnica	x	x	x	x		x	x		x	x	x	x
115	— cancellata	x	x	x	x	x	x	x			x		
116	— — subapiculata	x					x	x			x		
117	— digito-radiata	x	x	x	x	x	x	x		x			
118	— — Cyprinus	x			x		x			x	x		
119	— directa	x	x	x	x		x	x	x	x	x	x	x
120	— — remota	x	x		x		x	x				x	
121	— — subtilis	x						x	x	x	x	x	x
122	— distans	x			x		x	x	x				
123	— elegans	x	x	x	x					x			x
124	— forcipata	x	x		x		x			x	x		
		32	15	13	18	7	19	19	9	23	20	17	12

		Universal distribution							Distribution in the different parts of the coasts of Iceland				
		Eur.	Afr.	As.	Am.	Aust.	Gr.	A. S.	S.	S.W.	N.W.	N.	E.
5	(<i>Navicula forcipata</i>) <i>densestriata</i>	x	x	x	x		x				x	x	
6	— <i>fortis</i>	x			x		x	x			x		
7	— <i>fusiformis ostrearia</i> ...	x					x			x			
8	— <i>granulata</i>	x		x	x	x	x			x			
9	— <i>Grevillei</i>	x		x	x		x	x		x	x		x
0	— <i>halophila</i>	x								x			
1	— <i>Hennedyi</i>	x	x	x	x		x	x		x			
2	— — <i>circumsecta</i> ..	x	x	x	x		x			x			
3	— <i>humerosa</i>	x	x	x	x			x	x	x	x	x	
4	— — <i>constricta</i>	x		x						x			
5	— <i>inflexa</i>	x						x		x			
6	— <i>lanceolata phyllepta</i> ..	x								x			
7	— <i>latissima</i>	x		x	x			x	x				
8	— <i>Libellus</i>	x		x					x	x			
9	— <i>Lyra Ehrenbergi</i>	x	x	x	x	x	x	x			x		
0	— — <i>atlantica</i>	x									x		
1	— <i>mutica Cohni</i>	x	x	x	x	x		x	x				
2	— <i>palpebralis</i>	x	x	x	x			x	x	x	x		
3	— — <i>angulosa</i>	x								x			
4	— <i>peregrina</i>	x	x	x	x		x	x	x	x	x		
5	— <i>pusilla</i>	x	x	x	x	x		x	x	x			
6	— <i>rhombica</i>	x		x			x		x	x		x	x
7	— <i>ulvacea</i>	x								x		x	
8	— (<i>Schizonema</i>) <i>Bryopsis</i> ..	x							x			x	
9	— — <i>mollis</i>	x	x		x		x						x
0	— — <i>ramosissima</i> ..	x		x			x		x	x	x	x	x
1	— — <i>f. amplior</i>	x	x		x					x			
Nitzschia													
2	— <i>acuminata</i>	x		x	x							x	x
3	— <i>angularis</i>	x		x	x	x	x	x	x	x	x	x	
4	— — <i>affinis</i>	x					x			x	x		x
5	— <i>apiculata</i>	x		x	x		x	x		x		x	
6	— <i>bilobata</i>	x	x	x	x	x	x			x		x	
7	— <i>dissipata Acula</i>	x				x					x	x	
8	— <i>lanceolata</i>	x		x			x			x			
9	— <i>marginulata</i>	x			x	x		x		x	x	x	
0	— <i>paradoxa</i>	x	x	x	x		x	x			x		
1	— <i>Sigma</i>	x	x	x	x	x	x	x	x	x	x	x	x
2	— — <i>rigida</i>	x								x			
3	— <i>socialis</i>	x	x	x	x		x	x	x	x	x	x	x
		39	15	24	23	9	19	18	13	28	16	14	8

		Universal distribution							Distribution in the different parts of the coasts of Iceland				
		Eur.	Afr.	As.	Am.	Aust.	Grl.	A. S.	S.	S.W.	N.W.	N.	E.
164	(Nitzschia) Tryblionella littoralis	x			x					x			
165	— vitrea salinarum	x	x							x			
Pinnularia													
166	— quadratarea	x			x	x	x	x		x			
167	— Trevelyana	x		x	x						x		
Plagiogramma													
168	— Gregorianum	x	x	x	x	x	x	x			x	x	
Pleurosigma													
169	— cuspidatum	x				x				x			
170	— elongatum	x	x	x	x	x	x	x		x		x	x
171	— longum						x	x		x			
172	— Nubecula intermedia ..	x	x	x	x		x					x	
173	— Stuxbergi						x	x		x			
Podosira													
174	— hormoides	x			x	x	x		x	x	x	x	x
Rhabdonema													
175	— adriaticum	x	x	x	x	x			x				
176	— arcuatum	x	x	x	x	x	x	x	x	x	x	x	x
177	— minutum	x	x	x	x	x	x	x	x	x	x	x	x
178	— robustum				x				x				
Raphoneis													
179	— ampiceros	x	x	x	x	x				x			
Rhoicosphenia													
180	— curvata	x	x	x	x	x	x	x	x	x	x	x	x
Rhopalodia													
181	— Musculus	x	x	x	x	x			x		x		
Stauroneis													
182	— constricta	x			x					x		x	
183	— Gregoryi	x			x					x	x		
184	— salina	x	x		x	x	x	x		x			
Striatella													
185	— delicatula	x	x	x	x					x			
		19	12	11	18	12	11	9	6	16	8	8	

		Universal distribution							Distribution in the different parts of the coasts of Iceland				
		Eur.	Afr.	As.	Am.	Aust.	Grl.	A. S.	S.	S.W.	N.W.	N.	E.
6	Surirella												
	— <i>fastuosa</i>	x	x	x	x	x			x	x	x		
7	Synedra												
8	— <i>affinis</i>	x	x	x	x	x	x	x	x	x	x	x	x
9	— — <i>gracilis</i>	x					x	x	x	x	x	x	x
0	— — <i>fasciculata</i>	x		x			x	x			x		
1	— — <i>lanceolata</i>				x		x		x				
2	— — <i>parva</i>	x	x			x	x	x	x	x	x	x	x
3	— — <i>rupicola</i>	x					x		x				
4	— — <i>tabulata</i>	x				x	x		x	x	x	x	x
5	— <i>crystallina</i>	x	x	x				x	x				
6	— <i>Gailloni</i>	x	x	x	x				x	x			
7	— <i>Hennedyana</i>	x											x
8	— <i>investiens</i>	x					x		x	x	x	x	x
9	— <i>kamtschatica</i>						x	x		x	x	x	x
0	— <i>provincialis</i>	x								x			
	— <i>pulchella</i>	x		x	x		x	x	x	x	x	x	
1	Thalassionema												
	— <i>nitzschoides</i>	x			x				x				
2	Thalassiothrix												
	— <i>Frauenfeldi</i>	x		x			x					x	
3	Thalassiosira												
	— <i>gravida</i>	x			x		x	x		x			
4	Trachyneis												
5	— <i>aspera intermedia</i>	x			x		x	x	x	x	x	x	x
6	— — <i>pulchella</i>	x				x				x	x	x	x
7	— <i>Clepsydra</i>	x			x				x				
8	— <i>velata</i>		x	x	x	x				x			
9	Trigonium												
0	— <i>arcticum</i>	x	x		x		x	x				x	
1	Tropidoneis												
2	— <i>lepidoptera</i>	x	x	x	x	x		x		x			
	Total	195	95	113	134	75	115	107	87	145	101	92	64
	%	93	45	54	64	36	55	49	42	69	48	44	31

As regards the universal distribution, it appears from the above list, that the Icelandic coastal flora, as far as the Diatoms are concerned, has a predominant European character, but about one half of the European species can also occur in colder seas. The list of the distribution of the Diatoms in the different parts of the coast shows, that out of 209 species found in the samples, 145 or 69 % were found in S.W., 101 or 48 % in N.W., 92 or 44 % in N., 87 or 42 % in S. and 64 or 31 % in E. The Diatom-life therefore is most abundant on the South-West coast.

List of the species found in more than 50 samples.

	Total 438 samples		S. 58 samples		S.W. 191 samples		N.W. 30 samples		N. 98 samples		E. 53 samples	
	Number of samples	%	Number of samples	%	Number of samples	%	Number of samples	%	Number of samples	%	Number of samples	%
Rhabd. arcuat.....	303	69	38	66	126	66	21	70	77	79	36	68
— minut.....	231	53	34	60	113	59	27	90	42	43	15	28
Hyal. subt. v. scotic.....	209	48	28	48	110	58	24	80	39	40	7	13
Biddulph. aurit.....	180	41	14	24	83	43	29	97	34	35	17	32
Syn. aff. + var.....	174	40	13	22	77	40	27	90	50	51	17	32
Coccon. Scutell.	160	37	18	31	74	39	15	50	38	39	15	28
Podos. horm.....	156	36	24	41	79	41	19	63	17	17	14	26
Grammat. mar.....	155	35	31	53	98	51	11	37	12	12	3	6
Rhoicosph. curv.....	143	33	17	29	74	39	16	53	27	28	7	13
Grammat. ang. v. isl.	125	29	23	40	61	32	10	33	21	21	10	19
Coccon. cost.	119	27	10	17	49	26	18	60	28	29	14	26
Fragil. striat.....	82	19	12	21	30	16	5	17	13	13	20	38
Gomphon. exig.....	91	21	15	26	40	21	10	33	16	16	10	19
Melos. sulc.	81	18	5	9	61	32	9	30	6	6	0	0
Grammat. ocean. v. min..	66	15	19	33	38	20	4	13	5	5	0	0
Isthm. nerv.	64	15	20	34	24	13	3	10	7	7	7	13
Syn. invest.	62	14	17	30	25	13	5	17	8	8	7	13
Grammat. ang.	60	14	16	28	34	18	4	13	4	4	2	4
Trach. asp. var. pulch. ...	51	12	10	17	33	17	3	10	4	4	1	2

Not considering N. W. in the above list, which, owing to the small number of samples, gives a misleading percentage, it appears, that, of the frequently occurring species, the following are especially prominent:

in S. (with more than 50 %): Rhabd. arc. (66 %), Rhabd. minut. (60 %), Gramtph. marina (53 %).

In S.W. (with more than 50 %): Rhabd. arc. (66 %), Rhabd. min. (59 %), Hyal. subl. scot. (58 %), Gramtph. marina (51 %).

In N. (with more than 40 %): Rhabd. arc. (79 %), Syn. aff. + var. (51 %), Rhabd. min. (43 %).

In E. (with more than 30 %): Rhabd. arc. (68 %), Frag. striat. (38 %), Bidd. aur. (32 %), Syn. aff. + var. (32 %).

This shows, that Rhabd. arc. ist the most predominant Diatom along the coasts of Iceland.

CHARACTERISING FORMS.

By »characterising forms« I understand species, which, by their, frequent occurrence in a sample, may be considered to be characteristic for this. »Characterising forms« are of course far from being always found in a sample, but on the other hand, several such forms may very well be present in the same sample.

In the list below, I have given a synopsis showing the genera or species of Diatoms characteristically associated with the various genera of Algae. Where a figure is attached to the name of the Diatom it indicates the number of the samples in which the genus

	Rhodophyceæ	Number of samples	
		125	
1	Antithamnion	7	Grammatophora (2), Hyalodiscus scoticus, Podosira.
2	Bangia	6	Rhabd. arc.
3	Calithamnion	6	Achnanthes, Cocconeis, Grammatophora, Rhoicosphenia curv., Rhabd. arc. (2), Synedra.
4	Ceramium	9	Amphipleura rutilans, Podosira.
5	Chantransia	10	Cocconeis, Frag. striat., Licmophora (2), Rhabd. arc., Rhabd. min. (2), Synedra (2).
6	Delesseria	7	Cocconeis, Isthmia (2).
7	Halosaccion	9	Rhabd. arc., Rhabd. min. (2).
8	Lomentaria	2	Isthmia.
9	Melobesia	3	Grammatophora.
10	Petrocelis	5	Isthmia.
11	Phyllophora	1	Cocconeis.
12	Polysiphonia		Cocconeis (2), Grammatophora (3), Isthmia, Rhabd. arc. (2).
		15	
13	Porphyra	10	Licmophora (2), Synedra.
14	Ptilota	4	Cocconeis, Grammatophora.
15	Rhodochorton	19	Cocconeis (2), Gomphonema exiguum, Grammatophora (3), Rhabd. arc. (3), Rhoicosphenia curv., Synedra (2).
16	Rhodomela	7	Cocconeis (2), Isthmia, Licmophora, Rhabd. arc. (2).
17	Rhodymenia	4	Licmophora.
18	Turnerella	1	Rhabd. min.

or species in question is found; where no figure is added it means, that the genus or species in question has only been found in one sample.

The following are some of the more conspicuous characterising forms on Rodophyceae:

Rhabd. arcuat in 12 samples = 9.6 %, Cocconeis and Grammatophora each in 11 samples = 8.9 %, Licmophora and Synedra each in 6 samples = 4.8 %.

	Phæophyceæ	Number of samples	
		108	
1	Ascocyclus	1	Frag. vitrea.
2	Ectocarpus	38	Biddulphia aur., Gomphonema exiguum, Frag. striat. (3), Hyalodiscus scoticus, Licmophora, Navicula rhombica, Podosira, Rhabd. arc. (2), Rhoicosph. cur., Synedra (5).
3	Elachista	8	Rhabd. arc. (2).
4	Fucus	6	Isthmia, Rhabd. arc.
5	Isthmoplea	6	Frag. striat., Synedra.
6	Laminaria	1	Grammatophora, Podosira, Navic. (Schizonema).
7	Leptonema	2	Rhoicosph. curv., Synedra.
8	Lithoderma	4	Frag. striat., Grammatophora, Licmophora (3).
9	Myrionema	6	Biddulphia aur., Cocconeis (2), Frag. vitrea, Podosira, Rhabd. min.
10	Phyllitis	7	Cocconeis (2), Frag. striat.
11	Pogotrichum	9	Biddulphia aur., Cocconeis, Podosira, Rhabd. arc., Synedra (2).
12	Punctaria	1	Frag. striat., Synedra.
13	Ralfsia	8	Diploneis incurvata.
14	Sphacelaria	7	Cocconeis (3), Rhabd. min.
15	Stictyosiphon	4	Licmophora.

The following are some of the more conspicuous and characterising forms on Phaeophyceae: Synedra 10 samples, or 9.3 % of the samples, Cocconeis 8 samples or 7.4 %, Fragilaria striat. 7 samples or 6.5 %, Rhabd. arc. 6 samples or 5.6 %.

The following are some of the more conspicuous, characterising forms on the Chlorophyceae: Cocconeis 19 samples or 20.8 % of the samples, Fragil. striat. and Synedra each 6 samples or 6.5 %, Licmophora and Rhabd. arc. each 5 samples or 5.4 %.

It appears therefore, that on the Rhodophyceae, Rhabd. arc. and to some extent also Cocconeis and Grammatophora principally are the characterising forms; on the Phaeophyceae the Synedra

	Chlorophyceæ	Number of samples	
		92	
1	Acrosiphonia	25	Cocconeis (8), Licmophora (3), Frag. striat., Rhabd. arc. (4), Synedra.
2	Chætomorpha	2	Cocconeis, Rhabd. arc.
3	Cladophora	15	Amphora, Cocconeis (6), Synedra.
4	Codiolum	2	Frag. striat.
5	Enteromorpha	20	Achnanthes, Cocconeis (2), Melosira num., Navicula bottnica, Rhab. min. (2), Synedra (3).
6	Monostroma	11	Frag. striat., Melosira num.
7	Ochlochæte	1	Cocconeis, Synedra.
8	Rhizoclonium	5	Achnanthes (2), Cocconeis, Navicula pusilla.
9	Ulvea	1	Frag. striat.
10	Urospora	10	Biddulphia aur., Fragil. striat. (2), Licmophora (2), Rhabd. min.

is the most conspicuous form, while Cocconeis takes the lead on the Chlorophyceæ.

When examining how matters stand as regards the occurrence of the characterising forms in the 6 groups of Marine Algæ given by Helgi Jónsson in Bot. of Icel. part 1, pages 58—62, it appears, that in

Group A, The Arctic Group	I have found 1 charact. form in 3 samples
— B, The Subarctic Group, Subdiv. I	— — 13 — — - 14 —
— B, — — — — II	— — 36 — — - 32 —
— C, The Boreal-Arctic Group	— — 22 — — - 17 —
— D, The Cold-Boreal Group	— — 37 — — - 32 —
— E, The Warm-Boreal Group	— — 1 — — - 5 —

This shows, that the characterising forms are most frequent in groups B, C and D, which agrees well with the paramount European character of the Icelandic coastal Diatom-flora.

Finally, considering the occurrence of the characterising forms during the different months of the year, as far as this has been given in the samples, the facts are the following:

	Number of samples	Charact. forms	%		Number of samples	Charact. forms	%
January	3	1	33	July.....	57	12	21
Februar	0	0	0	August	51	14	27
March	10	5	50	September	42	19	45
April	37	16	43	October	18	2	11
May	72	27	38	November	0	0	0
June	107	37	35	December.	0	0	0

Apart from the months, January, March and October, in which less than 37 samples are present, the rest must be placed in the following order, according to their percentages: September 45, April 43, May 38, June 35, August 27, July 21.

This shows, that the number of the characterising forms increases with July in both directions.

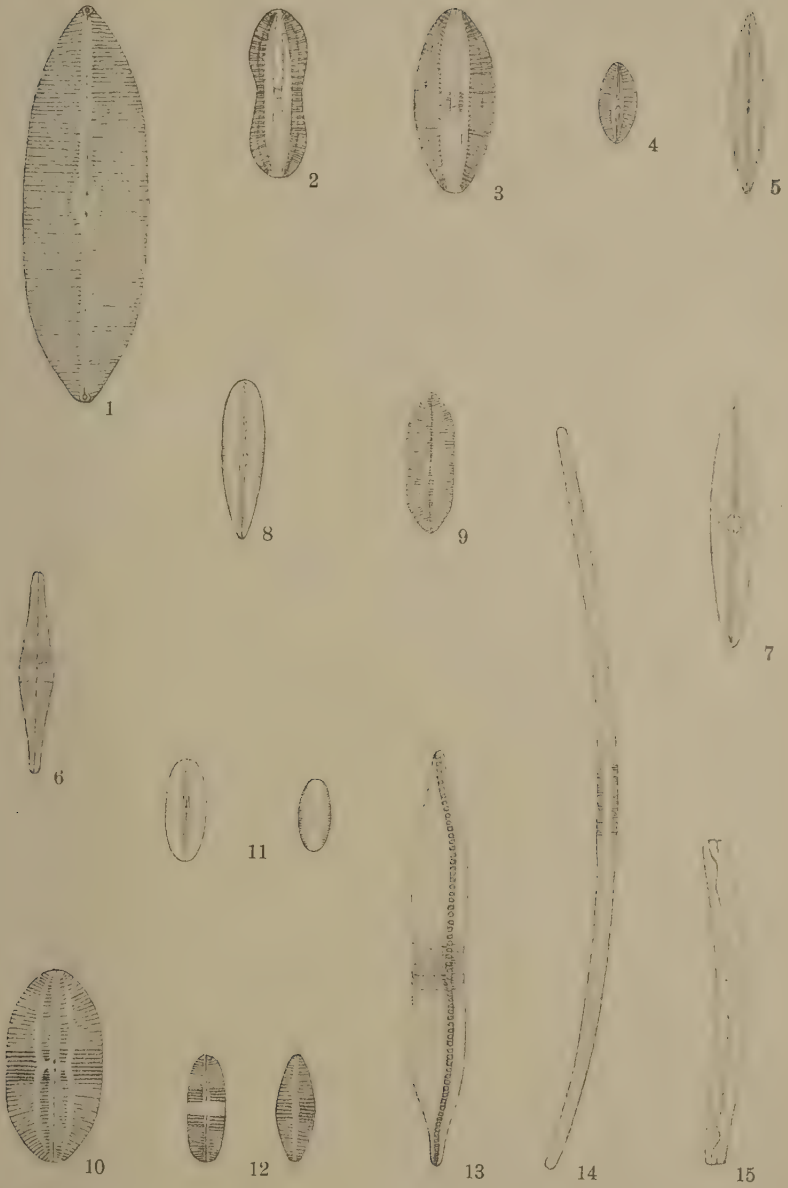
LITERATURE

- BRIGHTWELL, TH. On the genus *Triceratium* . . . Quart. Journ. Micr. Soc. I. London, 1853. (Bright. Tric.)
- CLEVE, P. T. On Diatoms from the Arctic. Sea. Bih. t. K. Sv. Vet. Akad. Handl. B. I, Nr. 13 Stockh., 1873. (Cl. A. S.)
- CLEVE, P. T. Diatoms collected during the Expedition of the Vega. Vega-Exped. Vetensk. Arbet. Iakttag. B. II. Stockh., 1883. (Cl. Vega Exp.)
- CLEVE, P. T. Synopsis of the Naviculoid Diatoms I—II. K. Sv. Vet.-Akad. Handl. B, 26, Nr. 2 and B. 27, Nr. 3. Stockh., 1894—95. (Cl. Syn.)
- CLEVE, P. T. und A. GRUNOW. Beiträge zur Kenntniss des Arctischen Diatomeen. K. S. Vet.-Akad. Handl. B. 17, Nr. 2. Stockh., 1880. (Cl. & Gr. A. D.)
- DE TONI, J. B. Sylloge Bacillariearum omnium hucusque cognitarum I—III Patavii MDCCCXCI—MDCCCXCIV. (De Ton. Syll.)
- DONKIN, A. S. The Natural History of the British Diatomaceæ. London, 1871—73. (Donk. Br. D.)
- GRAN, H. H. Nordisches Plankton. Kiel und Leipzig, 1905. (Gr. N. Pl.)
- GREGORY, W. On the Post-tertiary lacustrine Sand . . . from Glenshira. Trans. micr. Soc. III—IV. London, 1856. (Greg. T. M. S.)
- GREGORY, W. On new forms of Marine Diatoms, found in the Firth of Clyde and in Loch Fyne. Trans. Roy. Soc. Edinb. Vol. XXI. Edinburgh, 1857. (Greg. Clyd.)
- GRUNOW, A. Die österreichischen Diatomaceen. Verh. Zool. Bot. Ges. B. 12. Wien, 1862. (Grun. Øst. Diat.)
- GRUNOW, A. Vorläufige Bemerkungen zu einer systematischen Anordnung der Schizomena- und Berkeleya-Arten . . . Bot. Centralblatt B. IV, Nr. 47 & 48. (Grun. Bot. Centrbl.)
- GRUNOW, A. Die Diatomeen von Franz Josefs-Land. Denk. Akad. Wiss. Wien. B. XLVIII, Wien, 1884. (Gr. Fz. J.)
- HEIBERG, P. A. C. Conspectus criticus Diatomacearum Danicarum. Kjøbenhavn, 1863. (Heib. D. D.)
- KÜTZING, F. T. Die kieselschaligen Bacillarien oder Diatomeen. Nordhausen, 1865. (Ktz. Bac.)
- MANN, A. Report on the Diatoms of the Albatross Voyages in the Pacific Ocean, 1888—1904. Smithson. Instit. Contr. fr. the Unit. Stat. Nation. Herbar. Vol. X, Part 5. Washington, 1907. (Mann Albat.)
- PANTOCSEK, J. Beiträge zur Kenntniss der fossilen Bacillarien Ungarns. I—III. Nagy Tapolosány, 1886—93. (Pant. Ung.)
- PERAGALLO, H. Monographie du genre *Pleurosigma*. Le Diatomiste I. Paris. 1890—93. (Per. Pleur.)
- PERAGALLO, H. & M. Diatomées marines de France et des districts voisins, Grez-sur-Loing, 1897—1908. (Per. D. mar.)

- RATTRAY, J. A revision of the genus *Actinocyclus* Ehr. Journ. Quek. Micr. Club II, 4. London, 1890. (Ratt. Actinoc.)
- SCHMIDT, ADOLPH. Die in den Grundproben der Nordseefahrt . . . enthaltenen Diatomaceen. II. Jahresber. d. Komm. z. Unters. d. deut. Meere in Kiel, Berlin, 1874. (A. S. N. S. D.)
- SCHMIDT, ADOLPH. Atlas der Diatomaceenkunde, Aschersleben 1874 — not yet completed. (A. S. Atl.)
- SMITH, WILLIAM. A Synopsis of the British Diatomaceæ I—II, London, 1853—1856. (W. Sm. Syn.)
- VAN HEURCK, HENRI. Synopsis des Diatomées de Belgique I—IV, Anvers, 1880—85. (V. H. Syn.)
- VAN HEURCK, HENRI. Traité des Diatomées. Anvers, 1899. (V. H. Trt.)
- ØSTRUP, E. Marine Diatoméer fra Østgrønland. Medd. om Grøn. XVIII, Kjøbenh., 1896. (Øst. Østg. mar.)
- ØSTRUP, E. Kyst-Diatoméer fra Grønland. Medd. om Gr. XV. Kjøbenh., 1898. (Øst. Kyst. D)

EXPLANATION OF PLATE

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E. Østrup del.

Pacht & Crone phototyp.

4.

THE BRYOPHYTA OF ICELAND

BY

AUG. HESSELBO

WITH 39 FIGURES IN THE TEXT

INTRODUCTION.

PREVIOUS to the time when Grönlund made botanical collections in Iceland (1868 and 1876) the Bryophyta of the island was very little known. Earlier botanists, who occasionally collected specimens also of the Bryophyte Vegetation, have only exceptionally given information as regards localities, and the older lists consist merely of an enumeration of species without any information as regards distribution or frequency. To this must be added that the older determinations of species are very uncertain, and in many cases undoubtedly erroneous or quite improbable, and that the lists are compiled quite uncritically without stating the name of the collector or the source of the information. For instance, more than half of the 149 mosses and 54 hepatics enumerated in Lindsay's list are undoubtedly wrongly determined, and the majority of them beyond doubt do not occur in Iceland. Therefore, in preparing the following list of the Bryophyta of Iceland, older records have been taken into consideration only when it has been possible to verify them by means of specimens in the collections.

The material dating from older collections (previous to Grönlund's) is but very scanty. Mörch was the first to contribute anything of importance to our knowledge of the Bryophyta of Iceland. In 1820 he collected a rather considerable number of species, among which are many that were not found again until quite recently, and even several which have not since been found by others. Mörch's collections are in the Botanical Museum in Copenhagen, but unfortunately he has in only quite a few cases recorded the habitat on the wrappers. W. J. Hooker (1809), Lindsay (1860) and Carroll (1861) collected mosses and hepatics in Iceland, but as mentioned above, Lindsay's list, in which

these finds are enumerated, is so full of mistakes that it is quite worthless.

Japetus Steenstrup collected (1839–40) some Bryophyte samples in West and North Iceland and in the interior of the country.

But it was not until Grönlund's investigations that the foundation was laid of a real knowledge of the Bryophyte Vegetation of Iceland, he not only critically revised the older lists, but also prepared lists of his own collections. It was also Grönlund who was the first to give real descriptions of moss societies. Grönlund's journeys in 1868 and 1876 extended over West and North Iceland, from Reykjavik across Esja to Borgarfjörður and thence to Skagafjörður, Eyjafjörður and Mývatn. He did not visit East, South and North-west Iceland.

In recent times the Iceland botanists Ólafur Davidsson, Stefán Stefánsson and Helgi Jónsson have contributed considerably to our knowledge of the Bryophyta of Iceland.

Ólafur Davidsson (died 1902) made, during 1899–1900, very considerable and valuable collections in North Iceland around Eyjafjörður and Skagafjörður and on the small island of Grimsey north of the Arctic Circle. His collections, which belong to the Reykjavik Museum, have only now been determined.

Stefán Stefánsson, the head of a school in Möðruvellir and member of the Althing up to 1916, has made collections during many years, especially in North and North-east Iceland. The greater part of his material is published in Grönlund's list.

Helgi Jónsson, Dr. phil. and teacher in Reykjavik, on his numerous journeys to almost all the different parts of the island, has everywhere collected specimens of the Bryophyte Vegetation, and in his descriptions of the vegetation of Iceland has usually mentioned the Bryophyta also. His collections, which are preserved in the Botanical Museum in Copenhagen, are determined by C. Jensen. Besides the botanists mentioned above, a few others have also occasionally collected specimens of the Bryophyte Vegetation. C. Ostenfeld, during a few short visits, has especially investigated the lava-fields and the hot springs near Reykjavik and on the peninsula of Reykjanes. A. Feddersen (1884–86) made some collections in South and West Iceland. Dr. C. Hansen, Professor Th. Thoroddson and Pétur Sophoniasson collected mosses

in several places. The majority of these collections are determined by C. Jensen and included in Grönlund's list (1895).

My own investigations were made on three journeys, viz. in 1909 and 1912 by the aid of the Carlsberg Fund, and in 1914 by the aid of the Botanical Travelling Fund, and Japetus Steenstrup's Legacy. In 1909 I investigated in the beginning of June the region around Reykjavik and Hafnarfjörður, and made a five day's trip to the Esja mountains. On June 9th I sailed to Hornafjörður in South-east Iceland, and after staying a few days there went straight through East Iceland to Seydisfjörður, where I arrived on June 30th. On the way I stopped at several farms, viz. Stafafell, Hof, Djupivogur, Berufjörður, Höskulstadr and Vallanes. On July 9th I took the coast steamer to Husavik in North Iceland, and after some days sojourn there went into the interior of the island across Ás and Svinadal to Reykjahlid near Mývatn, and after having stayed a few days there to Akureyri. Unfortunately investigation in this interesting region was almost entirely prevented by continual rain and fog. I stayed five days in Akureyri and then continued my journey westwards through North Iceland to Stadur near Hrutafjörður, stopping at the farms Tverá in Öxnadalur, Vidimýri, Vidivellir, Geitaskard, Hnausar and Lækjarmot. From Stadur I rode across Haukadalsheidi and Brattabrekki to the farm Dalsmýnni in Nordredalur, where I arrived on August 2nd. After staying a few days there in continual rain, I was obliged to abandon my original plan of travelling by land to Reykjavik and, instead, to ride to Borgarnes and take the steamer to Reykjavik.

In 1912 I arrived at Reykjavik on June 2nd and rode thence past Kolvidarhol to Reykir, where the vegetation around the hot springs was investigated, and thence to Skálholt, Laugardalur and Thingvellir, staying a few days at each place, and then back again to Reykjavik, whence I sailed on June 15th to Dýrafjörður in North-west Iceland. On the way I had an opportunity during a 24 hours stay in Stykkisholmur to investigate the immediate neighbourhood. After a three days stay at Dýrafjörður I rode on June 20th to Isafjörður, whence, during the following three weeks, I made numerous excursions, partly, on foot, to the surrounding country and to Sugandafjörður, and partly to the north-west side of the fjord and the district around Jökulsfjörður, to Hesteyri and the whole tract of land from the head of Jökulsfjörður to Stadur, and from Bæir to Arngerdareyri.

On July 10th I returned to Reykjavik by the steamer "Botnia", and rode thence through Esja and around Hvalfjörður to Reykholtalur, where I stayed some days and investigated the hot springs, and made an excursion to the farm Gilsbakki. On my way back I passed through Reykholtalur and Lundurreykjadalur to Thingvellir, and thence to Reykjavik.

On my last journey in 1914 I stayed on the island of Vestmannaey, which I had previously had opportunity to visit only for a few hours, on my way to Reykjavik, from the 4th to 9th July. I went to Reykjavik on the 10th, and rode on the same day to Kolvidarhol, and thence further across Reykir and Thjorsártun to Fljotshlid near the Markarfljot, where I stayed some days at the farms Breidabolstadr and Barkarstadr. On the 17th I rode across the great river Markarfljot to the vicarage of Holt, south of Eyjafjallajökull, and stayed partly there and partly at the farms Drángshlid and Seljaland until July 24th, when I recrossed the Markarfljot on horseback, and rode past the farms Thjorsártun and Skálholt to Geysir, and thence across Thingvellir to Reykjavik, where my journey ended abruptly on August 1st on account of the outbreak of war.

As may be seen from the above survey, Iceland is as yet very incompletely investigated as regards bryology. All previous collectors, with the exception of Grönlund, had no, or almost no, knowledge of the Bryophyta, and have, therefore, only been able to take chance specimens, which must, therefore, often give a misleading idea of the composition of the vegetation. The great distances, together with a slow and toilsome journey on horseback, render investigation difficult, and rain and fog often greatly delay the work, and make it almost impossible to travel in the mountains.

The most thoroughly investigated regions are South-west Iceland from Eyjafjallajökull to Borgarfjörður, East Iceland from Hornafjörður to Seydisfjörður, the districts around Eyjafjörður in the north and around Isafjardardjup in the north-west. Throughout large parts of the country mosses have, practically, never been collected; thus, in the north-east from Seydisfjörður to Axarfjörður, in South Iceland from Vik to Hornafjörður, in the greater part of North Iceland and in almost the whole of the large interior plateau. Therefore this list of the Bryophyta found in Iceland can by no

means be regarded as complete, and future investigations will undoubtedly effect great alterations in our present knowledge of the distribution of the species in the different parts of the country.

ABBREVIATIONS OF NAMES.

O. D.	= Olafur Davidsson
F.	= Feddersen.
Grl.	= Grönlund.
Ho.	= Hornemann.
H. J.	= Helgi Jónsson.
C. J.	= C. Jensen.
Ostf.	= C. H. Ostenfeld.
St.	= Stefán Stefánsson.
Stp.	= Japetus Steenstrup.
! or (!)	= A. Hesselbo.
(!)	= The specimen seen by A. Hesselbo.
M.B.H.	= The Botanical Museum of Copenhagen.

I. LIST OF THE BRYOPHYTA.

I. HEPATICÆ.

FAM. RICCIACEÆ.

1. *Riccia bifurca* Hoffm.

N. Iceland: Hrossaberg (St.)!; Vidimýri (Gr.)!; Mývatn!. S. Iceland: Near Reykjanes lighthouse (Ostf.)!; Kverkfjall (Wegener.)!.

In all these localities it grows on warm, damp clayey flats near hot springs. Near Mývatn — where it grew abundantly around fumaroles, from which issued aqueous vapours containing sulphuretted hydrogen — the temperature of the soil was about $40^{\circ 1}$ about one cm. below the surface. Near Reykjanes lighthouse Ostenfeld (Bot. Tidsskrift, vol. XXII, 1899, p. 239) gives the temperature of the soil as 20° — 30° . All the plants investigated bore capsules.

2. *Riccia sorocarpa* Bischoff.

N. Iceland: Reykjalaug in Fnjoskadal (O. D.)!. S. Iceland: Grafarbakki near the Minni Laxá (F.)!; Laugaráshver!.

Like the preceding species, *R. sorocarpa* grows on warm, damp clayey flats. Near Laugaráshver it was found abundantly on clayey slopes stretching down towards the boiling hot spring. There the temperature of the soil was about 25° — 30° . All the plants investigated bore capsules which in the plants from Laugaráshver were fully ripe at the end of July.

3. *Riccia crystallina* L.

S. Iceland: Thorlakshver near Skálholt!. (27. 7. 1914).

The plants, which had fully developed capsules, grew widely scattered on clayey flats, otherwise bare of vegetation, around some small holes from whence issued boiling water accompanied by vapours slightly impregnated with sulphuretted hydrogen.

Note. *Riccia glauca* L. is mentioned by Zoëga and is recorded by Hornemann as occurring abundantly near Geysir. But as no specimens of it are to be found in the collections, and during the search made in 1914, no species of *Riccia* were found near Geysir, it is impossible to determine what species is meant.

¹ Here and throughout the book the centigrade scale is meant.

FAM. MARCHANTIACEÆ.

4. *Sauteria alpina* Nees.

N. Iceland: Grænuhnukr in Brattafjallgarði between Möðruvellir and Brú (St.).

5. *Reboulia hemisphærica* (L.) Raddi.

SW. Iceland: Hafnarfjörður (H. J.)! S. Iceland: Drángshlid (H. J.)!; Holt!; near Skógafos!; Seljaland!.

This plant was found only in the southern part of the country, but it appears to occur there rather frequently. Near Hafnarfjörður it was found in a lava cave; in S. Iceland it was collected everywhere from the somewhat damp faces of tuff rocks, especially from the base of the sides of illuminated caves in tuff cliffs; in this situation it usually grew in company with *Preissia commutata*, *Fegatella*, *Marchantia*, *Anoetangium compactum*, *Distichium montanum*, etc. It was found everywhere in fruit which was almost ripe at the end of July.

6. *Fimbriaria pilosa* (Wahlb.) Taylor.

N. Iceland: Hof (O. D.)!; Boggverstadadalur (O. D.)! NW. Iceland: Bæir on Snæfellsstrand!.

Near Bæir it grew abundantly on a stony slope facing south and stretching down towards the sea, upon rather dry, humus-covered rocks. It was everywhere collected in fruit which near Bæir had just ripened on June 6, 1912.

7. *Fegatella conica* Corda.

Hepatica conica Lindb.

S. Iceland: Drángshlid (H. J.)!; Merkjáfoss (F.)!; Breidabolstadr!; Barkastadr!; Seljaland!; Holt!; Drángshlid!; Skógafos!.

This plant was not found except in S. Iceland, but there it was common in all the parts which were investigated. It grew there everywhere on faces of tuff rocks, especially on those of caves and clefts, and more particularly on the faces with a southern exposure where it may occur very abundantly, sometimes on the damp tuff rocks themselves and sometimes creeping over mosses, for instance *Hypnum filicinum*, *Eurynchium Swartzii*, etc. Sterile specimens only have been found.

8. *Preissia commutata* (L.) Nees.

Chomocarpon quadratus (Scop.) Lindb.

N. Iceland: Hof, fr. (O. D.)!; Möðruvellir (O. D.)!; Hrossaberg on warm clayey flats, fr. (St.)!; Stora Gjá near Mývatn! NW. Iceland: Stadr on Snæfellsstrand, fr. (Stp.)! W. Iceland: common near the hot springs in Reykholtadalur!; Hafnarfjörður! S. Iceland: Thingvellir Grl.!

Laugardal (Grl.); Reykjanes near hot springs (Ostf.); common everywhere on faces of tuff rocks in Fljotshlid and below Eyjafjallajökull.

Preissia commutata occurs both on more or less damp ground and on damp rocks, and also on warm clayey flats near hot springs. In the last situation, as in Reykholtdalur, it covers large areas on slopes stretching down towards the boiling hot water. In E. Iceland it has not yet been found; in N. and NW. Iceland it is rather rare and grows there on damp rocks, along river-banks or in rock-clefts. In S. and SW. Iceland it is frequent in lava-clefts near Thingvellir and Hafnarfjörður, and in S. Iceland proper it is very common. There it grows at the base of, or some way up the rock faces, especially upon those with a southern exposure, or in sheltered clefts, and often occurs in great abundance, and fruiting richly. The fruit was not quite ripe even at the end of July.

9. *Marchantia polymorpha* L.

Common all over Iceland on damp soil, on rocks, by rivers, in marshes and in moss bogs, and very often found with fruit or antheridiophores. It is extremely common especially in NW. Iceland, and covers banks of streams often in great abundance, to a height of about 300 metres. In S. Iceland it is also very common on damp tuff rocks.

This species is most widely distributed in the birch zone to a height of about 300–400 metres above sea-level where it usually grows on marshy or gravelly ground along small streams, or occurs in abundance in moss bogs or in marshes among mosses. But it is also met with upon mountain heights, as for instance near Berufjörður, Seydisfjörður and Isafjörður, where it has been collected abundantly up to a height of 600–700 metres.

FAM. ANEUREÆ.

10. *Aneura pinguis* (L.) Dum.

Riccardia pinguis (L.) Gr.

Very common on damp ground both in marshes and on gravelly soil by rivers and also on damp rocks. It usually grows intermixed in the tufts of other Bryophyta, rarely forming tufts by itself; it has been collected in fruit in a few localities only (near Eyjafjörður, and near Seljaland at an altitude of about 500 metres). It is most widely distributed in the lowlands up to about 300 metres, but it is also frequently met with upon mountain heights.

11. *Aneura multifida* (Lindb.) Dum.

Riccardia multifida (Lindb.) Lindb.

E. Iceland: Lon!, on swampy ground among *Sphagnum rubellum*;
W. Iceland: Reykholtdal!, frequent near hot springs intermixed in the

tufts of other Bryophyta such as *Sphagnum rubellum*, *Scapania irrigua*, and *Pellia Neesiana*. In one place it was growing on a stone which protruded slightly above hot water of a temperature of about 50°; there it was growing intermixed in a tuft of *Enthostodon ericetorum*, *Scapania irrigua* and *Anthoceros punctatus*.

This species is recorded by Mörch from Iceland, but no specimens of it are to be found in the collections.

12. *Aneura latifrons* Lindb.

Riccardia latifrons (Lindb.)

N. Iceland: several places near Eyjafjörður (O.D.)!; Akureyri!; Husavik!. NW. Iceland: Laugarland!. SW. Iceland: Reykjavik!; Kollafjörður!.

This plant usually grows on peaty soil intermixed in the tufts of other Bryophyta such as *Dicranella crispa*, *Lophozia Kunzeana*, *Sphagnum* spp. and *Aneura pingvis*. Near Husavik it was growing among *Leptobryum pyriforme* on damp gravelly ground.

FAM. METZGERIEÆ.

13. *Metzgeria furcata* (L.) Lindb.

Commonly distributed all over Iceland in dry rock-clefts and on rock-faces, usually associated with *Radula complanata*. In S. Iceland, where it is very common on rock-sides in clefts of tuff rocks, it is sometimes found also in rather damp localities. Only sterile specimens have been found.

Metzgeria furcata is a typical lowland-plant. In Iceland it has not been found at a higher altitude than about 300 metres.

FAM. HAPLOLÆNEÆ.

14. *Pellia Neesiana* (Gottsche) Limpr.

Marsilia Neesiana Lindb.

Very common on wet ground especially along river-banks, in moss bogs and on inundated ground; somewhat more rare in marshes. It grows almost always intermixed in the tufts of other Bryophyta, and usually as an erect, elongated form among *Philonotis*, *Mnium cinclidioides*, *Acrocladium cuspidatum*, *Marchantia*, etc., more rarely it grows in unmixed tufts on damp ground. Fruit appears to be produced rather rarely and also rather sparingly.

This species has its main distribution in the lowlands up to about 300–400 metres, and it is only by exception that it has been found above this level.

Pellia epiphylla L. Lindb. is enumerated in the majority of the

older lists, and Grönlunds records it from many localities in Iceland, but all the specimens found in the collections under this name are those of *Pellia Neesiana*.

15. *Blasia pusilla* L.

N. Iceland: Reykum (Grl.); Melar (Grl.); several places near Mödruvellir near Eyjafjörður (O.D.); Reykjalaug in Fnjoskadalur (O.D.); Öxnadalur!; Stadr near Hrutafjörður!. W. Iceland: Gilsbakki!; common in Reykholtadalur!. S. Iceland: Reykirdalur!.

Only the ♂ plant has been found in Iceland.

This species occurs in rock-clefts and along the banks of streams, on wet gravelly ground, and also on clay near hot springs. For instance, it grows abundantly in Reykholtadalur, and more scantily in Reykirdalur on the damp, steaming clayey flats, the temperature of which just below the surface is about 25°–40°; it is found associated with *Gymnocolea inflata*, *Haplozia crenulata* and *Fossombronia Dumortieri*.

On banks of streams it usually grows rather scantily and associated with *Dicranella crispa*, *Pellia Neesiana*, *Didymodon rubellus*, *Angströmia longipes*, *Scapania subalpina*, etc.

Note. *Mörchia Blyttii* (Mörch) Brockm. is recorded by Grönlund to occur in Brynjudalur, but the specimens preserved in the Botanical Museum in Copenhagen belong to *Blasia pusilla*.

FAM. CODONIEÆ.

16. *Fossombronia Dumortieri* (Hüb. et Genth) Lindb.

N. Iceland: near Mývatn!. S. Iceland: near hot springs on Reykjanes (Ostf.); Reykir!; Thorlákshver!; Laugaráshver!; Sydri Reykjahver!; Thingvellir!; Kolvidarhóll!; Geysir (Ho.;!). W. Iceland: common near hot springs in Reykholtadalur!.

Fossombronia Dumortieri is one of those species which are rarely absent from the neighbourhood of any hot springs if only the water does not contain too much sulphuretted hydrogen. There it grows on warm clayey flats with a temperature of about 40°, and especially on damp slopes along the outlets of springs; as a rule it sets fruit which ripens during June–July.

In Reykholtadalur it is common near all the hot springs, also near the springs on Riskupstungur, near Geysir and on Reykjanes. In Reykirdalur, where the majority of the springs give out abundance of sulphuretted hydrogen in their vapours it occurred less frequently, but nevertheless was found near several springs, also around some small fumaroles near Kolvidarhol from which issued aqueous vapours impregnated with sulphuretted hydrogen. It grows in all these localities associated with other Hepaticæ, for instance *Gymnocolea inflata*, *Haplozia crenulata* and *Anthoceros punctatus*. Near Mývatn it was growing around a fumarole, on a damp clayey flat with a temperature of about 40°, associated with *Riccia bifurca* and *Haplozia crenulata*. The only place

where the plant has been found on other than warm ground is near Thingvellir where it was growing in a ditch along the road to Hrafnagjá, on clay washed together into a heap; there it had for companions *Dicranella crispa*, *Didymodon rubellus*, *Eucalyx subellipticus* and tiny plants of *Pohlia*, *Bryum*, etc.

FAM. EPIGONANTHÆ.

17. *Gymnomitrium corallioides* Nees.

S. Iceland: Thingvellir (Stp.; Grl.;!); Seljaland (Stp.;!). SW. Iceland: Reykjavik (Grl.;!); frequent in Esja!; Hafnarfjörður!. E. Iceland: frequent!. N. Iceland: Akureyri!.

Occurs rather commonly, but as a rule, not abundantly in SW., E. and probably also N. Iceland; in NW. Iceland it has not yet been found. It usually grows on the top of blocks of basalt and lava in small greyish cushions, and rarely on the dry gravelly soil of *Grimmia*-heaths. On the heath in Seljaland it occurred on blocks of basalt up to a height of about 400 metres; in Esja it has been found up to about 500 metres. Only sterile specimens have been found.

18. *Gymnomitrium concinnatum* (Ligthf.) Corda.

Commonly distributed over the whole of Iceland.

In the lowlands it is especially common in the lava-fields, where it grows both on the top of blocks of rock and in crevices and caves, generally mixed with other Hepaticæ such as *Lophozia alpestris*, *L. quinqueidentata* and *Pleuroclada albescens* v. *islandica*; but it is also frequently met with in clefts mixed with other Bryophyta and creeping over stones. But it has its greatest distribution from about 300—400 metres upwards towards the snow-line, where it grows both on more or less damp ground and on rocks either in low, extensive cushions or mixed with other Bryophyta such as *Lophozia alpestris*, *L. ventricosa*, *Pleuroclada albescens*, *Dicranum Blyttii* and *D. fulvellum*, usually also woven into dense cushions of *Conostomum boreale*.

In NW. Iceland especially, where it is one of the most frequently occurring Bryophyta, it grows on gravelly flats on mountain heights in extensive carpets associated with *Anthelia nivalis*, *Alicularia minor*, *Polypodium sexangulare* and the other above-mentioned Bryophyta. Near Seljaland, at about 650 metres, it was growing in great masses on weathered basalt rocks associated with *Marsipella emarginata*, *Polypodium sexangulare* and *Dicranum Blyttii*.

Fruit not rare; it ripens, according to altitude, during June—July.

19. *Gymnomitrium varians* (Lindb.) Schiffner.

NW. Iceland: Dýrafjörður! (at an altitude of about 350 metres) on damp gravelly ground; Reykjaheidi, in a lava-cleft!. Near Dýrafjörður it was growing abundantly in low, blackish-brown mats associated with *Anthelia nivalis* and *Alicularia minor* on ground saturated with melting snow.

20. *Gymnomitrium revolutum* (Nees) Phil.

NW. Iceland: Sugandafjörður! (at an altitude of about 200 metres). It occurred here, on wet gravelly soil upon a slope, scantily among *Hypnum callichroum*, *Dicranum Starkei*, *Scapania uliginosa* and *Lophozia Floerckei*.

21. *Marsupella Funckii* (W. et M.) Dum.

E. Iceland: Hof!, in brownish-black cushions about one cm. high, in rock-clefts associated with *Lophozia alpestris* and *Dicranum Andersoni*; Seljaland! (at about 350 metres), on the ground between blocks of basalt and mixed with *Marsupella emarginata* and *Dicranum Blyttii*.

22. *Marsupella emarginata* (Ehrh.) Dum.

NW. Iceland: Dyrafjörður on damp rocks at an altitude of about 250 metres!. S. Iceland: Holt! (at about 400 metres), on marshy ground among *Hypnum sarmentosum*, *Oncophorus virens*, etc.; Seljaland!, in several places from an altitude of 350 to 650 metres, both on gravelly soil and on rocks.

This species is recorded by Mörch from Iceland (figured in *Flora Danica*, tab 1945), and by Grönlund from Thingvellir and Hafnarfjörður. The specimen from Hafnarfjörður has proved to be *Anthelia julacea*. Mörch's specimens are not to be found in the collections.

23. *Marsupella aquatica* (Lindb.) Schiffner.

NW. Iceland: Kaldalon! by the bank of a small lake intermixed in a tuft of *Hypnum sarmentosum* and *H. exannulatum*; Isafjörður!, abundantly in an almost dried up river, at an altitude of about 250 metres.

24. *Alicularia scalaris* (Schrader) Corda.

Very common over the whole of Iceland.

Alicularia scalaris is one of the most commonly occurring Hepaticæ in Iceland, and is of almost equal frequency in the lowlands as in the higher mountainous regions. Fruit is rather common.

It grows especially on a somewhat damp substratum, both on rocks and on gravelly ground and also by streams and in bogs, sometimes as pale green or — in exposed localities — brownish mats, sometimes sprinkled in the tufts of other Bryophyta. On peaty ground it often forms extensive, continuous carpets in company with *Pogonatum urnigerum*. On warm clayey flats it also occurs abundantly, and forms together with *Haplozia crenulata* dense, reddish-brown or pale green mats along the warm water near both sulphurous and alkaline springs.

25. *Alicularia geoscypha* De Not.*Nardia minor* (Nees) Arnell, *N. haematosticta* Lindb.

Commonly distributed all over Iceland and, as a rule, fruiting.

This species doubtless occurs as frequently in the lowlands as on mountain heights upwards to the limit of plant-growth. It is generally met with on damp gravelly ground associated with other *Hepaticæ*, for instance by streams with *Cephalozia bicuspidata*, *Scapania subalpina*, *S. curta*, *Lophozia alpestris* and *L. Wenzelii*, or on damp gravelly ground on rocky flats with *Pohlia gracilis*, *P. commutata*, *Aongstroemia longipes* and several other species. On mountain heights, especially in NW. Iceland, it generally grows in company with *Anthelia Juratzkana* on gravelly flats irrigated by melting snow.

Var. *insecta* (Lindb.) K. M. was collected near Isafjörður (at about 300 metres alt.) together with the type.

Note. *Alicularia compressa* (Hooker) Nees is figured in *Flora Danica*, tab. 1772, fig. 2, and is recorded to have been found near Grönnefjord (?) by Mörch, but no specimens of it are to be found in the collections.

26. *Eucalyx subellipticus* (Lindb.) Breidler.

E. Iceland: Beruffjörður!; Seydisfjörður!. N. Iceland: Hof near Eyjafjörður (O. D.)!; Öxnadalur. NW. Iceland: Kaldalon!; Laugarland!; Grunnavik (at about 350 metres alt.); Gnupsdalur!. W. Iceland: Gilsbakki; Esja, several places!; Kolvidarhól!. S. Iceland: Thingvellir, several places!. It has been collected everywhere in fruit.

It is no doubt rather common but often overlooked on account of its diminutive size and resemblance in habit to the far more frequently occurring small species of *Alicularia* and *Haplozia*, with which it is generally associated. It is usually found on damp gravelly ground, more rarely on damp rocks or in lava-clefts; now and then in unmixed tufts, but generally mixed with *Alicularia scalaris* and *A. geoscypha*, *Scapania curta*, *Dicranella crispa*, *Pohlia* spp., etc. Near Hof it grew mixed with *Haplozia pumila*; in Almannagjá it occurred in many places at the bottom of clefts or on humus-covered ledges associated with *Lophozia alpestris*, *Alicularia geoscypha* and *Scapania subalpina*. Near Seydisfjörður it occurred creeping over stones by the river and mixed with *Haplozia atrovirens*.

27. *Haplozia crenulata* (Sm.) Dum.*Nardia crenulata*.

Near Geysir (Mörch; Stp.)!; figured in *Flora Danica*, tab. 1774, fig. 1, "in uliginis Islandiæ frequens, A. Mörch." Common near all the hot springs in Reykholtalur!, Reykirdalur!, on Biskupstungur!, on Reykjanes (Ostf.)!, near Laugarvatn!, in Lundurreykjadalur! and near Mývatn!. It was found also in W. Iceland: Borgarnes!, at several places along the road; Lækjarmot!, on wet ground in bogs. NW. Iceland: Laugarland!, on boggy ground.

Haplozia crenulata is in Iceland a decidedly warm-soil species which is hardly absent from any hot spring, whether sulphurous or alkaline. It grows there in abundance on warm clayey flats which have a temperature of 20° – 35° , near Mývatn even at a temperature of about 40° . It occurs far more rarely on peaty soil, and then only scantily. Curiously enough, these habitats, also, are situated in districts where there are hot springs. Near Laugarland, for instance at the edge of the marsh, there is a small spring with lukewarm water, but the heat from it can exert no influence on *Haplozia crenulata*, nor does the latter occur in the immediate neighbourhood of the spring.

This species varies considerably in colour, size, thickness of the cell-walls and as regards the leaf-margin. In the low, reddish-brown forms which grow on warm ground nearest to the hot water the cell-walls are more highly thickened, and are especially distinctly collenchymatous, while the more vigorous, green forms which grow at some distance from the spring on more boggy ground, among other Bryophyta, have thin-walled cells which are indistinctly collenchymatous. The marginal cells are sometimes large and thick-walled, sometimes scarcely larger than the other leaf-cells and then only slightly thickened; in such cases it may be difficult to distinguish the plant from the forms of *Haplozia sphærocarpa* and *Alicularia scalaris* with which it is often found associated. Under high magnifying powers the marginal cells will however always be seen to be somewhat papillose, which is never the case in *Alicularia*.

28. *Haplozia sphærocarpa* (Hook.) Dum.

S. Iceland: Grafarbakki near a hot spring (F.)!; Thorlákshver among *Catharina undulata*!; Sydri Reykjahver among *Oligotrichum hercynicum*!; Laugarvatnshver among *Sphagnum cymbifolium*!; Isafjörður on a rocky flat (300–400 metres above sea-level)!

All the forms found, which are quite sterile, stand slender and erect among other Bryophyta and must doubtless be referred more particularly to the type.

This species, like its companion *Oligotrichum*, has a very peculiar distribution in Iceland, having two such widely different areas of distribution as the warm clayey flat with a temperature of 25° – 30° and the rocky flat.

Note. A liverwort is figured in Flora Danica, tab. 2195, under the name *Jungermannia pumila*; it is recorded to have been found by Mörch near Lejrå. Lindberg, in his critical revision of the mosses in Flora Danica, refers it to *Jungermannia cæspiticia*, but the specimens are not to be found in the collections.

29. *Haplozia cordifolia* (Hook.) Dum.

Very common and often fruiting richly. It grows especially on rocks, in or by waterfalls; or submerged in rivers, where it sometimes covers large surfaces of the firm rocky bottom with its blackish-green mats. But it may also be met with on irrigated gravelly ground or in

moss bogs associated with species such as *Philonotis seriata*, *Chiloscyphus polyanthos* v. *fragilis* and *Scapania undulata*.

It is most widely distributed in the lowlands up to a height of about 300 metres, but is also frequently met with up to about 500 metres, for instance in Esja.

30. *Haplozia riparia* (Tayl.) Dum.

Vestmannaey. S. Iceland: Flokastadagil!; Klitnafoss!; Barkarstadr!; Holt!.

In all the above-mentioned localities the plant was growing on tuff and was, as a rule, fruiting. On Vestmannaey it was growing on "Stora Klit," on the surface of dripping tuff-rocks facing north, associated with *Hymenostylium curvirostre*, *Hypnum filicinum* and *Anomobryum filiforme*. In S. Iceland it is fairly common in damp ravines on Fljotshlid and below Eyafjall, and grows there partly associated with the above-mentioned species, partly in company with *Fegatella conica*, *Preissia commutata*, *Bryum oenum*, etc.

Haplozia riparia is recorded by Grönlund from Brynjudalur and Seydisfjörður, but the specimens from these localities must be referred to *Haplozia atrovirens*.

31. *Haplozia atrovirens* (Schl.) Dum.

Common on damp rocks, more rare on damp gravelly ground.

It occurs sometimes in low, blackish-green cushions, sometimes intermixed in the tufts of other Bryophyta. Male plants and fruiting plants are frequently met with, sometimes in separate tufts, sometimes mixed in the same tuft. Like *Haplozia cordifolia* it occurs most commonly to a height of about 300 metres, but is also frequently met with up to about 500 metres. Var. *sphaerocarpoidea* (De Not.) Mass. has a distribution similar to that of the type, and occurs in the same localities as the latter. Both forms pass evenly into each other.

The cuticle of the leaves, in the majority of the plants, is more or less distinctly rough with striæ, and rarely smooth.

32. *Haplozia pumila* (With.) Dum.

N. Iceland: Hof, near Eyjafjörður (O. D.)!. It was growing there intermixed in a tuft of *Eucalyx subellipticus*.

The rest of the specimens referred by Grönlund and Jensen to this species all belong to *Haplozia atrovirens*.

33. *Jamesoniella autumnalis* (De Cand.) Steph.

S. Iceland: Nuphlidarháls (Stp.)!.

34. *Sphenolobus minutus* (Crantz) Steph.

SE. Iceland: Lon, scantily among *Sphagnum rubellum* and *Fissidens osmundoides*. NW. Iceland: Hesteyri, in a tuft of *Dicranum elongatum*. W. Iceland: Grund in Skorradalur, among *Polytrichum strictum*.

This plant was first found by Mörch and figured in *Flora Danica*, tab. 2190, without a more precise notification of its habitat.

Grönlund's record of the occurrence of this species in Esja is due to an erroneous determination.

35. *Sphenolobus saxicola* (Schrad.) Steph.

"in Islandia leg Mörch" (M. B. H.)!. Figured in *Flora Danica*, tab. 2693, fig. 1, but no habitat is given.

36. *Sphenolobus politus* (Nees) Steph.

Isafjörður! c. coles.

It was growing there in several localities at an altitude of about 200—300 metres, sometimes along the banks of streams associated with *Harpanthus Flotowianus*, sometimes in bogs associated with *Sphagnum teres*, *Lophozia quinquedentata* and *L. Kunzeana*.

37. *Lophozia quinquedentata* (Huds.) Cogniaux.

Very common all over Iceland.

Lophozia quinquedentata is doubtless the liverwort of most frequent occurrence. It is met with, up to the snow-line, in all possible localities which are somewhat damp, now and then in unmixed tufts, but generally woven into the tufts of mosses. Female plants and fruit are rather rare, male plants are far more frequent; plants bearing gemmæ are also often met with.

It varies extremely as regards size, habit and leaf-form. The extreme members of the variation-series are the large var. *turgida* Lindb. which is common on boggy ground and the delicate, often only one mm. broad, var. *tenera* C. Jens. which is frequent in dry localities, as for instance on humus-covered rocks and in lava-fields.

38. *Lophozia lycopodioides* (Wallr.) Cogniaux.

Almost as common as the preceding species on drier ground. It is found especially on stony or grass-covered slopes, creeping over humus-covered rocks, in birch coppices, and on the top of knolls in bogs, sometimes in large, unmixed, yellowish-green tufts, sometimes intermixed with other Bryophyta. Only sterile specimens have been found. It varies considerably in size. Delicate forms (var. *parvifolia*), often only one mm. broad, grow on dry rocks woven into the tufts of other Bryophyta, while the large, vigorous forms are especially met with on slopes overgrown with *Hylacomium*. Now and then forms also occur which approach very closely to *Lophozia Hatscheri* (Evans) Steph. But plants which can with certainty be referred to this species have not been found in Iceland.

Lophozia lycopodioides is most widely distributed in the birch-zone, up to about 400 metres above sea-level, and is especially wide-spread towards the north-west while it occurs more sparingly in S. Iceland.

In the district around Isafjörður it is also met with abundantly on the rocky flat, 500—600 metres above sea-level, and near Akureyri it was collected, although sparingly, near the snow-line (at about 770 metres alt.).

39. *Lophozia Floercke* (W. et M.) Schiffner.

NW. Iceland: Dýrafjörður; Isafjörður; Hesteyri!; Grunnavik!; Kaldalon!; Arngerdareyri!. SW. Iceland: Svinahraun!.

In the majority of the older lists of Bryophyta from Iceland *L. Floercke* is recorded from rather a considerable number of habitats, but all the specimens from these habitats preserved in the Botanical Museum in Copenhagen, have been wrongly determined; the majority of them must be referred to *Lophozia lycopodioides*. The only specimen in the collections, correctly determined, was gathered by Mörch, but no habitat is given.

This species has a very peculiar distribution as it is very common in the north-west, and is also found abundantly on the highly situated Svinahraun in the south-west (about 300 metres), but has not otherwise been found in Iceland. In NW. Iceland it ascends from the low land to the rocky flat, but is most frequently met with from 200 to 400 metres above sea-level. There it grows on fairly dry ground in bilberry heaths, both on the ground and creeping over rocky blocks, associated with *Dicranum fuscescens*, *D. scoparium*, *D. molle*, *Lophozia lycopodioides* and *L. quinquedentata*. At a higher level it grows especially on the *Salix-herbacea*-flats, associated with *Lophozia ventriosa*, *L. alpestris*, *Dicranum Starkei*, *Pleuroclada albescens*, etc., but also occurs on a more damp bottom.

In Svinahraun it occurred commonly between the lava-blocks and also in a damp depression at the edge of the lava-field, associated with *Polytrichum commune*.

40. *Lophozia quadriloba* (Lindb.) Evans.

E. Iceland: Berufjörður!; Lon!; common near Seydisfjörður; Valanes!. N. Iceland: Husavik!; Akureyri!; about Eyjafjörður (O. D.;!). NW. Iceland: Kaldalon!; Isafjörður!. W. Iceland: Melar (Grl.)!; Esja, several places!. S. Iceland: Svinahraun!; Holt!; Hornafjörður!. The Vestmannaeyjar!.

This plant is no doubt common, but usually it occurs so scantily that it is only found by close search of the Bryophyte collections under the microscope. It grows both on damp humus-covered rocks and on boggy ground, from the low land upwards to the mountain-tops. Thus, near Isafjörður it was collected at about 440 metres. Near Seydisfjörður it is frequent up to about 500 metres and near Akureyri it was found on cliffs at an altitude of 900 metres.

Lophozia quadriloba hardly occurs in unmixed tufts, but always mixed with other species, for instance with *Dicranum* spp. or on rocks among *Distichium montanum*, *Tortella fragilis*, *Oncophorus*, or with other Hepaticæ such as *Cephalozia*, *Lophozia alpestris* and *Aneura pinguis*. On

boggy ground it is found interwoven with *Hypnaceæ* in their tufts, but rarely in those of *Cinclidium*, *Lophozia Kunzeana* or other bog-mosses.

The majority of the specimens investigated are small and delicate, and must partly be referred to forma *heterophylla* Bryhn et Kaalaas, and partly to forms transitional between this and the type. Only sterile plants have been found.

41. *Lophozia Kunzeana* (Hüb.) Evans.

Very common in bogs, on damp rocks, damp gravelly ground, etc.

It is most widely distributed in bogs where it grows woven into, or creeping over tufts of other Bryophyta, especially *Sphagnum*. Near Akureyri, for instance, it commonly occurs in bogs up to a height of about 600 metres. In S. Iceland it is rather rare in the bogs of the lowlands, but is met with abundantly at an altitude of 200–400 metres.

42. *Lophozia barbata* (Schmid.) Dum.

E. Iceland: Árbær, among *Grimmia canescens* (H. J.)!. W. Iceland: Bjarnarhöfn (H. J.)!; Berserkjahraun (H. J.)!; Reynivellir (GrL.)!; Nordredalur in the district of Borgarfjörður!; Álafoss!.

In addition to the above-mentioned localities Grönlund and Helgi Jónsson record this species from several other localities, but some of the specimens which have been investigated proved to be wrongly determined (being, as a rule, forms of *L. lycopodioides*), so only those localities are enumerated here from which authentic specimens are known.

L. barbata appears to be rather rare. It has as a rule been collected, intermixed rather sparingly in tufts of other Bryophyta especially *Grimmia* and *Hylocomium* spp. and belongs to the *Grimmia*-heaths or to the mossy bottoms of birch coppices; thus in Nordredal it frequently occurred in birch coppices among *Hylocomium* spp., *Dicranum scoparium*, *Ptilidium ciliare*, etc.

Note. *Lophozia gracilis* (Schl.) Stephani is recorded from several localities, but all the specimens which have been investigated have been wrongly determined, being mostly *Lophozia lycopodioides* var. *parvifolia*.

43. *Lophozia ventricosa* (Dicks.) Dum.

Common on more or less damp ground, both boggy and gravelly ground, and on rocks on mountain heights.

This species is very common especially in NW. Iceland, and occurs there on a heathy bottom woven into tufts of *Dicranum*; along the banks of streams associated with *Harpanthus*, *Lophozia quinquedentata* and *Cephalozia bicuspidata*; and in bogs among *Spagnum*. It appears, on the whole, to be more frequent the higher it ascends; undoubtedly its main distribution is from a height of about 300–400 metres upwards.

Var. *porphyroleuca* (Nees) Hartm. is likewise commonly distributed and occurs, for instance, frequently interwoven with *Conostomum* in its compact tufts, and also in tufts of *Dicranum* and *Sphagnum* on damp ground.

It is hardly possible to draw any distinct boundary line between this form and the type, the thickenings of the leaf-cells showing all transitional stages from quite thin-walled to decidedly collenchymatous cells, and the colour also varying according to the habitat. Fruit is rare; gemmæ are as a rule present.

Var. *confertifolia* (Schiffn.) syn. *Lophozia confertifolia* Schiffner. Plants agreeing exactly with the description of this form and with the figure in Rabenhorst's Kryptogamenflora, fig. 314, occur rather commonly on damp gravelly soil in NW. Iceland associated with all the transitional forms of *L. ventricosa*; I think they can only be regarded as Alpine forms of the present species.

44. *Lophozia Wenzelii* (Nees) Steph.

E. Iceland: Seydisfjörður!; Vallanes!. N. Iceland: Tverá in Öxnadalur!. NW. Iceland: Isafjörður, (at about 200 metres alt.!). SW. Iceland: Svinaskard (at about 400 metres alt.).

It grows on wet gravelly soil or peat, especially along streams where it forms low, dense carpets or grows mixed with *Alicularia scalaris*, *Dicranella crispa*, *Distichium inclinatum* and other Bryophyta. Near Isafjörður it was growing by a small stream together with *Sphagnum squarrosum*.

45. *Lophozia alpestris* (Schleich.) Evans.

Very common all over Iceland.

It generally grows woven into tufts of other Bryophyta, but now and then forms tufts by itself. It is found on almost every kind of substratum, from the sea-level to mountain heights. It occurs most frequently on rocks, especially those which are somewhat damp, but is also met with on damp ground along the bank of streams, on the gravelly flats of mountain heights, in lava-clefts and woven into the moss-carpet of *Grimmia*-heaths.

Fruit and calyces occur rarely and have been found only in NW. Iceland: Gnupsdal! and in S. Iceland: Seljaland (at about 350 metres!; Svinahraun!. Male plants are rather common, and gemmæ are very often present.

46. *Lophozia excisa* (Dicks.) Dum.

S. Iceland: Reykir!; fr.

It grows there on damp gravelly soil by a small stream associated with *Eucalyx subellipticus*, *Scapania curta* and *Dicranella crispa*.

This species is recorded from Iceland by Mörch, but of the two specimens found in the collection in the Botanical Museum in Copenhagen under this name, one is *Lophozia ventricosa* var. *porphyroleuca* and the other *L. heterocolpos*.

Note. *Lophozia bicrenata* (Schmid.) Dum. is recorded to have been found near Krisuvik by Steenstrup, but the packet contained only a mixture of several other species of *Lophozia*.

47. *Lophozia Schultzii* (Nees) Schiffner.

E. Iceland: Seydisfjörður; Vestdalur (at an altitude of about 200 metres)!. N. Iceland: Akureyri!. W. Iceland: Stykkisholmur!.

It was collected everywhere only in small quantities together with bog-mosses such as *Hypnum revolvens*, *H. stellatum*, *Mnium Seligeri*, etc.; it was as a rule sterile. Near Stykkisholm it was collected in unmixed tufts with antheridia and young calyces.

48. *Lophozia Mülleri* (Nees) Dum.

Common, but occurred almost always in small quantities intermixed in tufts of mosses.

This species is most frequent in the lowlands up to about 300-400 metres above sea-level, but it also occurs at great altitudes in the Alpine region, for instance, at about 600 metres on Berufjördurskard. It is almost always sterile.

Lophozia Mülleri occurs on very different substrata, most frequently on rocks, but it may also be found on damp ground along streams, or even in bogs. It varies exceedingly in size according to the degree of dampness of the habitat. Xerophilous forms from rocks are usually small and delicate, while bog forms which grow in the tufts of *Hypnaceæ* are considerably larger and often approach so closely to *L. Hornschuchiana* that they are difficult to distinguish from the latter. On the damp, vertical sides of the clefts of the tuff rocks of S. Iceland, for instance on Fljotshlid, a vigorous, blackish-green form is frequently met with forming large, pure mats.

49. *Lophozia Hornschuchiana* (Nees) Macoun.

Jungermannia bantryensis, Hooker.

E. Iceland: Seydisfjörður, frequent up to about 400 metres!. N. Iceland: Akureyri!; Hof; Eyjafjörður (O. D.)! c. coles. NW. Iceland: Isafjörður. W. Iceland: Dalsmýnne in Nordredal!; Mulakot!; Botnsdalur!; Reykjavik!; Kollafjörður.

Occurs rather frequently, but as a rule scantily, on boggy ground among mosses (*Hypnum*, *Sphagnum*, etc.), more rarely on stones in rivers. In Nordredal, for instance, it was found abundantly in a small river on submerged stones.

50. *Lophozia heterocolpos* (Thed.) Howe.

N. Iceland: Spönsgerde near Eyjafjörður (O. D.)!. NW. Iceland: Bæir!; Kaldalon!. SW. Iceland: Hafnarfjörður!; Esja!, at an altitude of about 400 metres; Thingvellir (Grl.)!.

In all the above localities it was found on humus-covered rocks, especially in clefts. Near Kaldalon it grew on damp rocks woven into a tuft of *Meesa trichoides* and *Dicranella subulata*; on Esja it grew upon damp tuff-rocks. In Thingvallahraun it is widely distributed in clefts

and caves in the lava-fields, usually mixed with *Blepharostoma trichophyllum*, *Amblystegium Sprucei*, *Diplophyllum albicans* and *Plagiothecium denticulatum*. The characteristic gemmiferous shoots occur always, but plants in fruit have not been collected.

51. *Gymnocolea inflata* (Huds.) Dum.

"In Islandia" leg. Mörch! and figured in Flora Danica, tab. 1945, fig. 2; SW. Iceland: Krisuvík (Stp.)!; Laugarvatn (Stp.)!; Reykholt (Grl.)!; Reykirdalur!; Kolvidarhol!. NW. Iceland: Laugarland!.

Grönlund records this species from several other localities besides those mentioned above, but the specimens in the Botanical Museum in Copenhagen are all wrongly determined and must be referred to *Lophozia Mülleri* or to *L. alpestris*.

In Iceland *Gymnocolea inflata* is a decidedly warm-soil plant which, with the exception of a single locality, was found exclusively on the steaming clayey flats around hot springs in SW. Iceland. Near Laugarland it was growing rather sparingly in a bog. *Haplozia crenulata* was growing in its neighbourhood, and as there was a small spring with lukewarm water at the edge of the bog it is possible that the occurrence of the two species is connected with the spring, although there was no characteristic vegetation around the spring, but only the common bog-plants.

In Reykirdalur, where it is found in abundance near almost all the hot springs, it forms extensive brownish-black or almost entirely black mats on warm ground with a temperature of as much as 40° around fumaroles or on slopes stretching down towards the boiling hot basins. At some distance from the spring it will grow woven into the tufts of *Polytrichum commune* or mixed with *Cephalozia bicuspidata* which likewise occurs in brownish-black forms.

It was collected with calyces only at Laugarvatnshver.

52. *Plagiochila asplenioides* (L.) Dum.

Very common everywhere.

Plagiochila asplenioides occurs on almost every substratum, on damp or on dry rocks, in bogs, on earth, etc. It is most frequent up to a height of about 300 metres above sea-level, but often occurs as far upwards as about 600–700 metres. Usually it grows intermixed in the tufts of other Bryophyta, more rarely it forms tufts by itself. The majority of the specimens which have been collected are small, only 1–2 mm. broad, with leaves slightly dentate or entire. Larger forms with leaves typically dentate occur mostly on somewhat damp ground, for instance among stones on a talus of loose blocks and debris (Urd) or in caves. Only sterile specimens have been found.

53. *Leptoscyphus anomalus* (Hook.) Lindb.

E. Iceland: Stöd (H.J.)!.

54. *Lophocolea cuspidata* Limpr.

Vestmannaey!. S. Iceland: Holt!.

On Vestmannaey it was found in several places at the base of cliffs and in specially large quantities in Heljusdal where it grew abundantly among stones on an Urd usually mixed with *Eurynchium*, *Stockesii* and *Mnium undulatum*. Near Holt it was found in several places, but everywhere only in small quantities in clefts of tuff-rocks, woven into the tufts of mosses. Only sterile specimens have been found.

55. *Lophocolea minor* Nees.

N. Iceland: Hálsskógur (O. D.)!. S. Iceland: Reykirdalur!; Vestmannaey: Heljusdal!.

In Reykirdalur it was growing rather sparingly on a grass-covered slope stretching down towards a stream. On Vestmannaey it occurred in several places associated with *L. cuspidata* sometimes intermixed in its tufts. In all the localities only sterile specimens were collected, but bearing the characteristic gemmæ.

56. *Chiloscyphus polyanthus* (L.) Corda.

Common in wet localities or in water, on gravelly ground and occasionally in bogs and on wet rocks. Only sterile specimens were found.

It occurs sometimes in unmixed cushions, which are usually blackish-green in colour in water and yellowish-green in boggy ground, sometimes mixed with other Bryophyta such as *Marchantia*, *Philonotis*, *Dicranella squarrosa* and *Mnium* spp. It is most widely distributed in the lowlands up to about 300 metres and does not appear to ascend much higher than 400 metres.

The typical form was collected only in S. Iceland on damp tuff-rocks near Holt. All the other plants which have been investigated belong to var. *fragilis* (Roth) K. M. It varies considerably as regards size and colour, but the form of the leaves and the size of the leaf-cells are almost always the same.

Note. *Chiloscyphus pallescens* is recorded from several places by Mörch, Grönlund and Helgi Jónsson, but all the specimens referred to this species belong to *Chiloscyphus polyanthus* var. *fragilis*.

57. *Harpanthus Flotowianus* Nees.

E. Iceland: Seydisfjörður, several places!. N. Iceland: several places around Eyjafjörður (O. D.)!; Stadr near Hrátafjörður!. NW. Iceland: Dýrafjörður; Sugandafjörður; Isafjörður; Grunnavík; Kaldalon; Arngerðareyri!. W. Iceland: Ólafsdalur in Dalasýsla (H. J.)!; Esja, several places!.

In NW. Iceland this species is of the most frequent occurrence among all the Bryophyta and is met with everywhere on wet ground up to a height of about 300 metres above sea-level. In the other parts of the country it is wanting or rare; on Esja it is however rather fre-

quent. It occurs both in bogs and along the banks of streams, and also on inundated gravelly ground, usually intermixed in tufts of mosses such as *Cinclidium*, *Mnium cinclidioides*, *Sphagnum* and *Hypnum* spp.; also on wet gravelly soil associated with *Lophozia quinquedentata*, *Cephalozia bicuspidata* and other Hepaticæ. Only sterile specimens have been found.

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58. *Cephalozia bicuspidata* (L.) Dum.

Very common on earth, damp gravelly soil, humus-covered rocks, and in bogs up to a height of about 600 metres above sea-level, especially in NW., N. and in parts also of E. Iceland, while it appears to be more rare in S. Iceland. It grows partly in large cushions, for instance on damp ground by streams, partly intermixed in tufts of mosses especially *Sphagnum* and *Dicranum* spp. and thrives best on a somewhat damp substratum. Found as a rule in fruit. It varies considerably as regards size and colour.

Var. *Lammersiana* (Hüb.) Bredler grows on very wet ground, for instance along banks of streams, where it forms large green mats in association with other Hepaticæ. It is especially common in NW. Iceland. The bog-forms, which grow erect among *Sphagnum*, are slender with spreading leaves. On damp slopes a dark-brown-to-black form frequently occurs, often forming very extensive carpets; it corresponds most closely with var. *Loeskeana* (Schiffner) K. M., in previous lists it was referred to var. *Lammersiana*. At the head of deep lava-caves and at the bottom of lava clefts it occurs in association with *Alicularia scalaris* as much elongated shade-forms.

Note. *Cephalozia Francisci* is recorded by Mörch from Hafnarfjörður, but the specimen in the Botanical Museum is *C. bicuspidata*.

59. *Cephalozia ambigua* C. Mass.

NW. Iceland: Laugarland, fr.!

It grew there in small brownish tufts on the damp ground at the bottom of the valley.

60. *Cephalozia pleniceps* (Aust.) Lindb.

Common in all parts of Iceland except in the southern part, where it appears to be rare. It is especially common in NW. Iceland and forms there one of the most frequently occurring Hepaticæ.

It occurs especially on damp ground and in bogs, woven into tufts of *Sphagnum*, *Dicranum* and *Mnium hornum* or associated with *Lophozia Kunzeana*, *L. quinquedentata* and other Hepaticæ and as a rule bears calyces or fruit. It occurs most frequently up to a height of about 300 metres, but it is also often met with at far greater altitudes.

Var. *macrantha* (Kaalas et Nichols.) K. M. is widely distributed on wet ground, and grows in association with similarly elongated forms of

C. bicuspidata and *Cephaloziella Hampeana*, woven into the tufts of *Sphagnum* spp., but is as a rule sterile.

Note. *Cephalozia conniven*s is recorded by Mörch and Grönlund as found in Iceland, but all the specimens which have been investigated belong to *C. pleniceps*.

61. *Cephalozia media* Lindb.

N. Iceland: Arnarfellsaurar (St.); NW. Iceland: Grunnavik!, intermixed in tufts of *Dicranum fuscescens*.

62. *Pleuroclada albescens* (Hook.) Spruce.

E. Iceland: Seydisfjörður!, common above a height of about 400 metres N. Iceland: Akureyri!, common above 500 metres; Hestahraun (St.)!. NW. Iceland: Very common above 300 metres!. Var. *islandica* (Nees) Spruce. N. Iceland: Reykjaheidi!. S. Iceland: Thingvallahraun (Mörch; Stp.; Grl.); Hafnarfjörður!.

The typical form is no doubt common on mountain heights, at any rate in N., NW., and E. Iceland. In S. Iceland it has not yet been found. On mountain heights it grows on stony flats associated with *Dicranum* spp. (*D. Starkei*, *D. molle* and *D. fuscescens*), *Lophozia* spp. and *Cesia concinnata* or associated with *Polytrichum sexangulare*, *Lophozia ventricosa*, *Cesia concinnata*, etc., on *Salix-herbacea*-flats.

The variety belongs especially to the lava-fields and grows there at the bottom of deep clefts, creeping over blocks of lava, often in abundance. It occurs there either in large whitish-green cushions or mixed with *Hylocomium* spp., *Rhacomitrium hypnoides*, *Polytrichum alpinum*, *P. sexangulare*, *Lophozia* spp., etc. Only sterile specimens of each form have been found.

63. *Cephaloziella Hampeana* (Nees) Schiffn.

Very common, but occurs only as scattered shoots intermixed in the tufts of mosses, sometimes, however, also in tiny, yellowish-green, brownish or reddish tufts upon these.

It occurs on highly different substrata. On rocks and on earth it grows in tufts of *Dicranum* spp., *Ditrichum flexicaule*, *Distichium montanum*, *Tortella fragilis*, etc.; in bogs it has been found woven into tufts of *Sphagnum*, *Sphaerocephalus palustris*, *Hypnaceæ*, *Oncophorus* spp. and several others. Bog-forms, with elongated stems and widely spreading, very much projecting leaves, agreeing most closely with var. *erosa* Warnst., occur very commonly in *Sphagnum* cushions.

The leaf-tissue varies very considerably, the leaf-cells, even on the same plant, being sometimes quite thin-walled, sometimes more or less thickened; the leaves also are more or less outspread, so that all possible transitional forms between this species and *Cephaloziella rubella* are known.

64. Cephaloziella rubella (Nees.) Warnst.

Typical specimens of this species were collected in the following localities:

S. Iceland: Hornafjörður!. E. Iceland: Seydisfjörður!. N. Iceland: Hafrardalur (St.)!; Akureyri!, at an altitude of about 500 metres!; Hof (O. D.)!. SW. Iceland: Kollafjörður!. S. Iceland: Holt!.

It was found everywhere woven into tufts of *Sphagnum* spp. and *Dicranum* spp. (*D. fuscescens* and *D. angustum*) and usually mixed with *Cephalozia bicuspidata* and *Lophozia* spp., now and then also with *C. Hampeana*. Near Isafjörður it grew sparingly in a tuft of *Mnium hornum*, which was densely interwoven with *Cephalozia pleniceps*. It was collected everywhere in fruit.

C. rubella is an uncertain species which when sterile is in many cases hardly distinguishable from *C. Hampeana*.

C. divaricata and *C. bifida* are recorded from several places in Iceland, but the specimens belong either to *C. Hampeana* or to *C. rubella*. Grönlund's *C. divaricata* from Melar is *Lophozia quadriloba*.

65. Odontoschisma Sphagni (Dicks.) Dum.

W. Iceland: Snældubeinstadahver in Reykholtdalur!.

It was found in the above locality in small quantity woven into a tuft of *Sphagnum rubellum* on a warm substratum.

This species is recorded from Iceland in several old lists and is figured in Flora Danica, tab. 2251 (leg. Mörch), but all the specimens found in the collections under this name are those of *O. elongatum*.

66 Odontoschisma elongatum (Lindb.) Evans.

"In Islandia" (Mörch!). E. Iceland: Hof!; Lon!; frequent near Seydisfjörður!. N. Iceland: Hvarf (St.)!; Akureyri!. W. Iceland: Budahraun (H. J.)!; Grund in Skorradalur!; common around Reykjavík!. S. Iceland: Holt! at an altitude of about 400 metres.

It grows usually woven into tufts of bog mosses such as *Sphagnum*, *Hypnum* and *Oncophorus* spp., *Meesia trichoides*, *Lophozia Kunzeana*, more rarely upon moss-tufts or on wet ground, in small brownish tufts. Only sterile specimens have been found.

A specimen collected by Mörch, having tiny, inconspicuous underleaves and less thickened cell-walls bearing fine warts, forms a transitional form to *O. Sphagni*.

67. Odontoschisma denudatum (Mart.) Dum.

W. Iceland: Braudarholt near Reykjavík! ♂.

It grew in the above locality on boggy ground among other Bryophyta.

68. **Odontoschisma Macouni** (Aust.) Underwood.

S. Iceland: Bergarfoss near Hornafjörður!; E. Iceland: Grottafoss near Seydisfjörður! at an altitude of about 200 metres. N. Iceland: Hof (O.D.)!. SW. Iceland: Svinahraun!.

This plant grows partly in small unmixed tufts, partly mixed with other Bryophyta such as *Anoetangium lapponicum*, *Distichium montanum*, *Pohlia cruda*, *Blepharostoma trichophyllum* on damp humus-covered rocks. In Svinahraun it grew in lava-clefts filled with humus.

69. **Calypogeia Trichomanis** (L.) Corda.

N. Iceland: near Mývatn (Grl.!); Reykjahlid!. W. Iceland: near several hot springs in Reykholtalur!; Tunguhver (probably Deildatunguhver) (Grl.!); Kollafjörður!. S. Iceland: Laugaráshver!; Geysir!. Moreover, Grönlund records this species from Hvammur, but no specimens of it are to be found in the collections.

The plant grows in all the above localities on a warm substratum. Near Reykjahlid it covered the roof of a lava-cave which had a temperature of about 25°. In the other localities it occurred on a warm damp substratum woven into mosses such as *Sphagnum*, *Hypna* and *Polytrichum*, or in pale green to brownish cushions above them. In Reykholtalur where it occurred abundantly in several localities, the temperature in the tufts was from 25° to 27°.

70. **Lepidozia setacea** (Web.) Mitten.

S. Iceland: Merkjáfoss (Feddersen)!.

It was found very sparingly in the above locality associated with *Cephalozia pleniceps* and woven into a tuft of *Dicranum scoparium*.

FAM. PTILIDIOIDEÆ.

71. **Blepharostoma trichophyllum** (L.) Dum.

Very common from the lowlands up to about 500—600 metres above sea-level.

This species rarely forms unmixed tufts, but grows almost always woven into tufts of other species and is met with in the most varied localities, on boggy ground and damp gravelly ground along rivers, in lava-fields, on damp rocks, and especially in abundance in rock-caves where it often covers the roof and walls in association with *Amblystegium Sprucei*, with a thin dark-green layer.

Fruit occurs rather rarely; but it is found plentifully in Almanagjá!, and near Hof in N. Iceland (O.D.)!.

72. **Chandonanthus setiformis** (Ehrh.) Lindb.

In the herbarium of the Botanical Museum there is a specimen, labelled by Mörch "In Islandia, among *Trichostomum canescens*, Aug. 1820."

73. *Anthelia julacea* (L.) Dum.

Common in the lowlands on damp gravelly ground and creeping over wet stones in streams, occasionally also on damp boggy soil; fruit is not rare. It does not appear to ascend higher than about 400 metres above sea-level.

74. *Anthelia Juratzkana* (Limpr.) Trevis.

Anthelia nivalis (Sw.) Limpr. ex. p.

Very common on damp gravelly flats irrigated by melting snow, somewhat rarer on damp gravelly ground along streams or on damp rocks.

This plant has its main distribution on mountain heights where, on the clayey or gravelly flats next to the snow-covered areas, it forms large, continuous carpets of a peculiar bluish-black colour, often mixed with *Salix herbacea* or with other Bryophyta such as *Alicularia geoscypha*, *Lophozia ventricosa* and *Polytrichum sexangulare*. In NW. Iceland, where the snow on slopes with a northern exposure may remain during the greater part of the summer, these *Anthelieta* often descend to sea-level. The plants growing on damp rocks or gravelly ground in lower levels differ from the typical form from mountain heights in being lighter in colour, usually yellowish green, and in the tufts being as a rule higher, with less close-set leaves; or it may also grow intermixed with other Bryophyta especially Hepaticæ.

A. Juratzkana and *A. nivalis* are so closely related that in many cases it is impossible to determine them when sterile. While the typical *A. Juratzkana*, as it occurs in abundance on mountain heights, is very characteristic because of its extensive low carpets, quite typical specimens of *A. julacea* are far more rarely met with on the damp soil of the lowlands. Of far more frequent occurrence are forms which pass, more or less, in habit, size of leaf-cells and thickness of cell-walls from *A. julacea* towards *A. Juratzkana*.

75. *Ptilidium ciliare* (L.) Hampe.

Very common both on dry and on somewhat damp ground.

The plant grows both among *Hylocomium* spp. on slopes and intermixed in heaths of *Rhacomitrium hypnoides* and *R. canescens* on more or less damp rocks coated with soil, and also in clefts in lava-fields and on knolls in bogs. It occurs most frequently in low-lying regions up to about 300—400 metres, but may also occasionally be met with on mountain heights. Only sterile specimens have been found.

FAM. SCAPANIOIDEÆ.

76. *Diplophyllum albicans* (L.) Dum.

"In Islandia" (Mörch!). W. Iceland: Budahraun (H.J.)!; Hafnarfjörður (Gr!.; H. J.;!); Svinahraun!; Möðruvellir in Kjos!. S. Iceland: Thingvalla-

hraun (Grl.; Stp.); Krisuvík (Stp.); Holt; Reykirdalur!, at an altitude of about 260 metres.

Diplophyllum albicans is a plant characteristic of the lava-fields of West and South Iceland and occurs there in great abundance on vertical rock-sides in clefts and caves, while it appears to be entirely absent from the lava-fields of North Iceland. Outside the lava-fields it has been gathered only extremely sparingly among stones on heaps of debris at foot of cliffs (Urd). In Reykirdalur it grew scantily on a warm substratum among large blocks of basalt. Only sterile specimens have been found.

77. *Diplophyllum obtusifolium* (Hook.) Dum.

"In Islandiae montibus leg. Mörch" and figured in *Flora Danica*, tab. 1831, fig. 2. No specimens of it are to be found in the herbarium of the Botanical Museum. In the district of Seydisfjörður!, on a damp rock-face by the river it occurred in a small quantity in a tuft of *Dicranum molle* and *Lophozia Kunzeana*. In N. Iceland: Ásbyrgi!, it was found on the ground among fallen blocks of lava. Only sterile specimens have been found.

78. *Scapania subalpina* N. ab Es.

Common on damp ground along streams, on damp rocks, in clefts and on damp slopes of the low land. It does not appear to ascend much higher than about 300 metres.

♂ plants are very common; calyces and fruit occur occasionally.

The plant varies in having deeply toothed to almost entire leaves. It is usually green or yellowish-green in colour, but sometimes reddish or brownish to almost blackish-brown in more exposed localities.

79. *Scapania remota* Kaalaas.

N. Iceland: Akureyri!.

The plant, which agreed exactly with the description and figure in Karl Müller's *Monographie der Lebermoosgattung Scapania*, grew in the above locality, in a bog 400 metres above sea-level, intermixed in tufts of *Oncophorus virens*.

80. *Scapania irrigua* (Nees) Dum.

Very common on damp ground, in bogs, along streams and on damp rocks.

This species is most widely distributed in the lowlands up to about 300 metres above sea-level, but may also frequently be met with at high altitudes in the Alpine regions. In wet localities, especially in bogs, where it occurs everywhere woven into the tufts of other Bryophyta, it is usually yellowish green in colour. The leaves are entire or fewly toothed towards the apex with thin-walled or slightly collenchymatous cells. But occasionally vigorous, brownish-green forms

also occur with more highly thickened cell-walls. In somewhat drier localities it is usually brownish in colour and more compact with more deeply toothed leaf margins, sometimes almost as in *S. subalpina* and with more thick-walled cells. Small forms from damp sandy soil often constitute transitional stages to *S. curta*, while vigorous aquatic forms approach closely to *S. undulata*. A very vigorous form with leaves which were as deeply toothed as in *S. subalpina* was found in abundance in lava-clefts near Thingvellir.

♂ plants are common; calyces and fruit occur rather rarely.

Note. *Scapania compacta* is recorded by Grönlund from Esja, but the specimen in the Botanical Museum is really *Scapania irrigua*.

81. *Scapania uliginosa* (Sw.) Dum.

E. Iceland: Stöð (H. J.)!. NW. Iceland: Gnupsdal in Dýrafjörður!; Sugandafjörður!; Isafjardarheidi!; Dýnjandi!; Arngerdareyri.

With the exception of a single locality in E. Iceland this species was found only in NW. Iceland where it is rather common on very wet or irrigated soil along streams, often occurring in great abundance up to a height of about 400 metres. Near Arngerdareyri it grew abundantly in a bog in reddish-brown tufts associated with *Hypnum* spp. The leaf-form and habit in this form were typical, but the leaf-cells had brownish and rather thickened walls and a roughly granular cuticle.

The plant from Sugandafjörður differed from the type in its leaves being sometimes distantly toothed and the cells very slightly thickened at the angles, in which respects it approached *S. irrigua*.

82. *Scapania paludosa* C. M.

NW. Iceland: Gnupsdal in the district of Dýrafjörður, c. coles.! Grunnavík ♂!; Isafjörður ♂!.

In Gnupsdal the plant grew abundantly in the water in small streams, where it formed large, loose, green to brownish mats. The leaves were highly decurrent, with indistinct teeth or entire margins, and thin-walled cells.

Near Isafjörður and Grunnavík it grew on wet boggy ground. The leaves in both these forms were shortly decurrent and more or less toothed with a broadly reniform or (often in the same plant) cordate postical lobe which was occasionally furnished with a small point as in *S. irrigua*; the leaf-margin was often reflexed as in *S. undulata*; the cells were thin-walled, but towards the margin occasionally somewhat thick-walled. The commissure is typically short and strongly curved with broad wings.

83. *Scapania dentata* Dum.

Scapania purpurascens (Hook.) Pearson.

E. Iceland: Berufjörður!; Seydisfjörður!. common up to about 400 metres. Kirkjuból (H. J.)!. N. Iceland: Stora Gjá!. W. Iceland: Hvammur

(Gr!); Esja!, common up to about 400 metres above sea-level; Hafnarfjörður!; S. Iceland: Krisuvík (Stp.)!; Krókr (H. J.)!; Almannagjá!; Holt!; Seljaland!; Austerhlið near Geysir!.

This species has its main distribution in E. and SW. Iceland and it has not been found in NW. Iceland. It grows especially on wet rocks and often in the water itself, but also on gravelly soil along the margin of streams. Thus, near Seydisfjörður it occurred abundantly along several rivers. In such localities it forms extensive reddish-brown cushions several centimetres deep.

On damp soil and on rocks it forms low cushions, green, rose-red or reddish-brown in colour. In the lava-fields near Hafnarfjörður and Thingvellir and in Stora Gjá it usually grew at the bottom of the comparatively dry caves and clefts in small, flat tufts of a peculiar yellowish-green or beautiful rose-red colour. Such forms from comparatively dry localities have always deeply-toothed leaves while the aquatic forms have less deeply-toothed, sometimes almost entire leaves, in which feature they approach *S. undulata* very closely. The cell-walls are however always more highly thickened than in the latter species, especially at the angles, and the postical lobe of the leaves are longer and narrower obovate (in *S. undulata* almost circular). ♂ plants and fruit are of frequent occurrence.

84. *Scapania undulata* (L.) Dum.

Very common on stones and gravelly soil in rivers, occasionally also on inundated ground in swamps and moss bogs.

This plant occurs most frequently in the low land up to about 300 metres, and forms there, especially creeping over stones in the shallow water along rivers, extensive growths in association with *Chiloscyphus polyanthus* var. *fragilis* and *Haplozia cordifolia*. Not rarely it is also met with at higher levels, for instance near Dyrafjörður, where it grew abundantly on slopes irrigated by melting snow, 400–500 metres above sea-level; and near Holt below Eyjafjall, where it was found abundantly in a stream even at an altitude of about 600 metres. The aquatic forms are usually green; in swamps and moss bogs it often forms extensive, thick carpets, reddish-brown or almost purple in colour. It is frequently found in fruit.

The leaves are entire or have a few obtuse teeth at the margin, but forms sometimes occur with more deeply toothed leaves or even with the leaf-margin entirely toothed, in the latter case it may be difficult to distinguish the plant from *S. dentata* and from the large aquatic forms of *S. irrigua*. The latter, however, have always cells more thick-walled especially at the angles, while *S. undulata* has always thin-walled leaf-cells.

85. *Scapania curta* (Mart.) Dum.

Common on rocks coated with soil, damp sandy or gravelly ground and on peat, occasionally also on boggy ground up to about 400 metres above sea-level. Near Isafjörður and in Esja it was collected at an

altitude of almost 500 metres. ♂ plants are common, fruit rather rare. The majority of the plants bear gemmæ.

Var. *geniculata* (Mass.) C. M.

S. Iceland: Reykir!; Vestmannaey! NW. Iceland: Ármuli!

Var. *rosacea* (Corda) Carr. is only exceptionally met with typically developed, while forms transitional between the present variety and the type are rather common.

The plant is usually green or brownish-green, more rarely reddish. On damp ground it becomes larger and approaches *S. irrigua*. The leaves vary somewhat in form. The antical lobe is usually pointed, in the lower leaves it is, however, often rounded; it is more rare for all the leaves to be rounded. The leaf-cells are as a rule thin-walled or somewhat thickened at the angles. Forms with highly thickened, reddish-brown cell-walls are more rare, and occur always in exposed localities.

86. *Scapania Bartlingii* (Hampe) Nees.

Scapania Carestiae de Not.

S. Iceland: Drángshlid associated with *Amphidium Mougeottii* and *Bryum archangelicum* (H. J.)!.

Note. *Scapania nemorosa* is enumerated in the majority of the older lists, but all the specimens in the collections belong to *Scapania undulata*.

FAM. RADULOIDEÆ.

87. *Radula complanata* Dum. Gottsche.

S. Iceland: Hornafjörður! E. Iceland: Hof!; Djupivogur!; Seydisfjörður! N. Iceland: Thrastarhólsárgil, fr. (O. D.)! W. Iceland: Flatey (Gr.)!; Budahraun (H. J.)! Common in SW. and S. Iceland!

The plant is common in E., W. and S. Iceland, while it appears to be absent from NW. Iceland and to be rare in N. Iceland.

It occurs only in the lowlands and rarely ascends higher than about 300 metres. In a few localities in Esja and near Kolvidarhol it was collected at an altitude of about 400 metres. It grows especially on dry, or only slightly damp, shaded rock-sides, mostly in clefts and caves, in company with *Metzgeria furcata*, *Lejeunea cavifolia*, etc., and often bears gemmæ and in S. Iceland fruit also. It was sometimes collected on the bark of trees, viz. on birch on Flatey and on mountain ash in Budarhaun.

FAM. MADOTHECOIDEÆ.

88. *Madotheca Cordæana* (Hübener) Dum.

Madotheca rivularis (Dicks.) Nees.

"In Islandia" (Mörch)! E. Iceland: Hof!; Seydisfjörður (H. J.)!; Berufjörður! NW. Iceland: Dýrafjörður! at an altitude of about 150 metres;

Dýnjandi!; Grunnavík! at an altitude of about 270 metres. W. Iceland: Nordredalur!; Brynjudalur (Gr!.)!; Reykjavík (Gr!.;!)!; several places in Esja!. Common in S. Iceland!. Vestmannaey!

This plant is most widely distributed in S. Iceland where, as on Vestmannaey, it is common on more or less damp rock-sides especially in clefts of the tuff mountains on Fljótshlíð and below Eyjafjall. On Vestmannaey it grew sometimes in abundance among fallen stones in Heljúsadalur, and sometimes on slopes associated with *Thuidium abietinum* and *Hylocomium* spp. In E. and NW. Iceland it was rarer and generally occurred only sparingly on faces of basalt rocks immediately above the surface of the water of rivers or on damp slopes among stones. This species has not yet been recorded from N. Iceland.

FAM. JUBULEÆ.

89. *Frullania dilatata* Nees.

W. Iceland: Flatey, on mountain ash (name of finder not stated); Dalasýsla, Melar, on sea-fowl cliffs (H. J.)!. Only sterile specimens have been found.

90. *Frullania Tamarisci* Nees.

Common both on dry and on somewhat damp rocks in company with *Hypnaceæ*, *Grimmia* spp., *Antitrichia curtipendula*, etc.; in *Rhacomitrium* heaths (both *R. canescens* and *R. hypnoides*); on slopes among *Hylocomium* spp.; on the top of knolls in marshes, etc.

I do not think the plant occurs at a much higher altitude than about 300 metres and it is always sterile.

91. *Frullania fragilifolia* Tayl.

SW. Iceland: Hafnarfjörður, in a lava cave (Gr!.)!; Kolvidarhol!; on a rock-face at an altitude of about 400 metres associated with *Radula* and *Lejeunea*.

92. *Lejeunea cavifolia* (Ehrh.) Lindb.

Lejeunea serpyllifolia (Dicks.) Spr.

"In Islandia" (Mörch)!. W. Iceland: Snæfellsnes!; Sandur in a lava cave (H. J.)!; Hafnarfjörður in lava caves!; Kolvidarhol!. S. Iceland: Seljaland (Stp.)!; common on Fljótshlíð and below Eyjafjall!: Thingvallabraun!.

This plant is common in S. Iceland where it grows especially on shady rock-sides in the clefts and caves of tuff mountains, associated with *Metzgeria furcata*, *Madotheca Cordeana*, *Amphidium Mougeotii*, etc. The habitat of greatest altitude is near Kolvidarhol at about 400 metres above sea-level, there it grew on a rock-face associated with *Radula* and *Frullania fragilifolia*.

Besides in the tuff districts, it is also rather frequent in the lava-fields where it grows at the bottom of deep, damp clefts, but as a rule only in small quantities. Sterile specimens only have been found.

FAM. ANTHOCEROTACEÆ.

93. **Anthoceros punctatus** L.

W. Iceland: Reykholtdalur (Ho.; Grl.;!). S. Iceland: Reykirdalur!; Sydri Reykjahver!. This species was first collected by Koenig and figured in Flora Danica, tab. 396.

It occurs near the majority of the hot springs in Reykirdalur. It grows there abundantly on damp clay-flats with a temperature of 20°—30°, associated with *Fossombronia*, *Haplozia crenulata* and *Archidium*, especially on slopes immediately above the hot water. It almost always bears numerous capsules.

II. SPHAGNALES.

1. *Sphagnum imbricatum* (Hornsch.) Russow.

S. Austini Sull.

S. Iceland: Thorlákshver and Laugaráshver near Skálholt!. It grew there on the warm substratum along the outlets from the hot springs in immense yellowish-brown cushions as much as 25 cm. deep.

2. *Sphagnum cymbifolium* (Ehrh.) Hedw.

W. Iceland: near several hot springs in Reykholtldalur!. S. Iceland: Thorlákshver!; sydri Reykjahver!; Laugarvatnshver!; Hurdarbak (H. J.!).

In all the above localities it grows on damp ground around hot springs.

3. *Sphagnum medium* Limpr.

NW. Iceland: Bæir!; Ármuli!. S. Iceland: Common in the district around Skálholt!. W. Iceland: Reykjavík!

The plant grows everywhere in wet bogs.

4. *Sphagnum papillosum* Lindb.

W. Iceland: Reykjavík!, common on boggy ground; Reykholtldalur (Grl.;!), around numerous hot springs. S. Iceland: Hraun; Grimstadr (H. J.!).; Hraundalsbraun (H. J.!).; Sydri Reykjahver!.

In Reykholtldalur *Sphagnum papillosum* constitutes the bulk of the vegetation around the hot springs and, for instance at Deildatunguhver, covers large areas of the warm, damp ground with cushions as much as about 20 cm. deep. It appears to be rather widely distributed in S. Iceland and is found there, as near Reykjavík, on the knolls in the bogs, sometimes on a rather dry substratum.

5. *Sphagnum inundatum* Russow.

W. Iceland: Grundarfjörður (H. J.!). S. Iceland: Thorlákshver!; Sydri Reykjahver!.

In the two latter localities it grew along the outlets from the hot springs, near Sydri Reykjahver it grew also on the knolls in a small bog near the spring.

6. *Sphagnum Gravetii* Russow.

NW. Iceland: Hesteyri!.

It grew there in pools in company with a very large form of *Hypnum revolvens* v. *Cossoni*.

7. *Sphagnum compactum* De Candolle.

S. rigidum Schimp.

S. Iceland: Nuphlidarháls near Krisuvík (Stp.)!.

8. *Sphagnum teres* (Schimp.) Ångstr.

Very common everywhere on damp ground up to a height of about 600 metres above sea-level.

S. teres is the most commonly occurring species of this genus and is almost as frequent in the lowlands as in the Alpine region, at high levels. It grows both on knolls in bogs and on more or less damp slopes and is also common on warm ground.

It is almost always green or pale yellowish-green in colour. Forms with appressed leaves are by far the most frequent; f. *squarrosulum* (Lesq.) is met with here and there, e. g.: Esja, Akureyri, Stadr near Hrutafjörður and Laugaráshver. The walls of the chlorophyll-cells are very often distinctly papillose. Only sterile specimens have been found.

9. *Sphagnum squarrosum* Crome.

N. Iceland: Mývatn (Gr!.); Litlu Borgarkatlar (St.)!; Grimsey (O. D.). NW. Iceland: Isafjörður!; Grunnavík!; Sugandafjörður!.

In NW. Iceland it is rather common up to about 300 metres above sea-level. It grows there sometimes on knolls in bogs and sometimes on more dry ground, thus, near Isafjörður it grew in several places on slopes stretching down towards the rivers. Only sterile specimens have been found.

10. *Sphagnum fimbriatum* Wils.

N. Iceland: Akureyri!; Geitaskard!. NW. Iceland: Dýnjandi!; Laugarland!. W. Iceland: Ketilstadr (H. J.)!; Stykkisholmur (H. J.)!; Nordredalur in the district of Borgarfjörður!. S. Iceland: Geldingsey (H. J.)!.

This plant grows usually on very wet ground in bogs and is no doubt commonly distributed in northern and western Iceland. Thus, near Stykkiðholm it was common in bogs, and also around Akureyri where it occurred abundantly up to about 400 metres above sea-level.

11. *Sphagnum Girgensohnii* Russow.

E. Iceland: Eskifjörður (H. J.)!; common near Seydisfjörður!. N. Iceland: common near Eyjafjörður (O. D.); Geldingafell (St.)!; Hafrardalur

(St.)!. Hvaneyrardalur (St.)!. NW. Iceland: common near Isafjörður!; Dýrafjörður!; Dýnjandi!. W. Iceland: Budir (H. J.)!; Nordredalur in Borgarfjörður!. S. Iceland: Almannagjá!; Laugarvatn!; Ingjaldshóll (H. J.)!; Heidi in Mýrdalur (H. J.)!; Seljaland!.

Commonly distributed both on knolls in bogs and on drier ground. Thus, in lava-clefts near Thingvellir, it is frequently met with on humus-covered blocks associated with *Rhacomitrium hypnoides* and *Hylocomium* spp. It is of most frequent occurrence in the lower country, but near Eyjafjörður it ascends to about 600 metres and near Isafjörður to about 400 metres above sea-level. Fruit was found in several places. It occurs especially in orthocladous forms.

12. *Sphagnum Russowii* Warnst.

S. Iceland: Thingvellir!.

13. *Sphagnum Warnstorffii* Russow.

Common on knolls in bogs and on damp ground on slopes up to a height of about 500 metres.

Reddish forms are of most frequent occurrence, violet, green and yellowish-green forms are far more rarely met with. Only sterile specimens have been found.

14. *Sphagnum rubellum* Wils.

Common on knolls in bogs and on wet slopes especially in the lowlands, but it also frequently ascends to about 500 metres above sea-level. Red and violet forms are frequent, green ones are rarer. Only sterile specimens have been found.

15. *Sphagnum acutifolium* Ehrh.

"In Islandia leg. Mörch"! N. Iceland: Hof (O. D.)!. NW. Iceland: Isafjörður!; Ármuli!. W. Iceland: Reykholtdalur on warm ground (Grl.); Reykjavík!; between Thingvellir and Geysir (Grl.).

Occurs here and there on boggy ground in the lowlands and as a rule rather sparingly. Near Isafjörður it was found in a bog at an altitude of 250 metres. Only sterile specimens have been found.

16. *Sphagnum subnitens* Russ. et Warnst.

NW. Iceland: Bæir!; Thorvaldsdalur (St.)!. W. Iceland: Grund!; Snældubeinstadahver in Reykholtdalur!; Reykjavík (H. J.); S. Iceland: Laugaráshver!; Borg (H. J.)!; Krisuvík (Stp.)!.

Found here and there in NW., W. and S. Iceland where it occurs both in bogs and along the margin of hot springs. It is frequent around Reykjavík where it was also gathered in fruit. It is as a rule pale yellowish-green in colour. Near Laugaráshver a f. *violascens* was found growing in large cushions on warm ground.

17. *Sphagnum Lindbergii* Sch.

W. Iceland: Ketilstadr among *S. fimbriatum* (H. J.)!.

18. *Sphagnum riparium* Ångst.

NW. Iceland: Thoroddstadaengjar (St.)!; common in pools and in very wet parts of bogs near Jökulsfjörður!.

19. *Sphagnum angustifolium* C. Jens.

N. Iceland: Akureyri!. W. Iceland: Reykholtdalur near a number of hot springs!. S. Iceland: Reykirdalur!; Laugaráshver!.

This species occurs abundantly along outlets from the hot springs in deep cushions of a pale green, yellowish or light brownish-yellow colour. The leaves are distinctly wavy in all the plants from a warm substratum. Its occurrence at Akureyri is peculiar; there it grew at an altitude of about 500–600 metres on wet boggy ground as a slender, pale-green, but otherwise typical, form. Only sterile specimens have been found.

20. *Sphagnum Dusenii* C. Jens.

W. Iceland: Snældubeinstadahver in Reykholtdalur!.

In the above locality it grew in large yellowish-brown tufts in warm water of a temperature of 25°, near a hot spring.

MUSCI VERI

FAM. ANDREÆACEÆ.

1. *Andreæa petrophila* Ehrh.

Very common all over Iceland. In the lowlands it grows in small round cushions on blocks and on rocks in dry situations and in such localities it is often the dominant species. On mountain heights, where it is frequently met with right at the upper limit of vegetation, it often descends upon the ground, even upon damp gravelly flats, where it forms extensive cushions almost black in colour. Fruit is almost always present.

Note. *Andreæa rupestris* L. = *A. Rothii* W. M. is recorded by Mörch from Iceland and is figured in Flora Danica, tab. 2125, but Mörch's specimens must be referred to *A. petrophila*.

FAM. ARCHIDIACEÆ.

2. *Archidium phascoides* Bridel.

W. Iceland: Reykholtalur!, near all the hot springs (Grí.;!); Englands-hver!. S. Iceland: Reykirdalur!; Reykjanes (Ostf.); Kolvidarhol!; Thorlákshver!; Laugaráshver!; Sydri Reykjahver!; Geysir!.

Archidium phascoides occurs in the collections under different names. It was first collected by Grönlund and determined by Zetterstedt as *Leskea nervosa*. Afterwards this specimen with several others were re-determined by Grönlund as *Catoscopium nigratum* var. *Grönlundii* established by C. Jensen. All the plants collected by Ostenfeld from Reykjanes are determined by C. Jensen as *Pohlia nutans* v. *filicaulis*. The reason for all these erroneous determinations will be found in the fact that the plant is almost always found barren and in leaf-form and cell-tissue presents a certain resemblance to mosses belonging to quite different groups, which often leads to the belief that the specimens in question are stunted forms or have been affected by the warm substratum: thus, certain forms bear a striking likeness to a slender *Amblystegium compactum*. The plant is typical of warm clay flats, and in S. and W. Iceland it is met with around every hot spring. On the warm clay flats with a temperature of 20°–40°, it forms extensive yellowish-green mats 1–2 cm. high. On slopes stretching down towards the boiling water and along outlets from the springs it is also frequently found growing within a few centimetres from the water, usually mixed

with *Haplozia crenulata* and *Fossombronina Dumortieri*, more rarely with *Gymnocolea inflata*. It is almost always sterile; on plants from Thorlákshver flowers as well as a few ripe capsules were found, besides, here and there at the bottom of the tufts, the characteristic large spores (9. 6. 1912).

Note. *Phascum cuspidatum*, *Ephemerum serratum* and *Sphærangium muticum* are enumerated on older lists, but no specimens of these species are to be found in the collections and their occurrence in Iceland is very improbable.

FAM. WEISIIACEÆ.

3. *Gymnostomum rupestre* Schleich.

E. Iceland: Geithellir!. N. Iceland: Akureyri!; Möðruvellir; Hof (O. D.)!. W. Iceland: Brynjudalur (Gr!.)!; Esja!. S. Iceland: Skálholt!; Thingvellir!.

Around Eyjafjörður it is common on damp rocks up to a height of about 300 metres; it was also found in numerous localities in SW. and S. Iceland and is common, for instance in Esja. It occurs especially on damp rock-sides near waterfalls and in clefts, often forming extensive mats; now and then it is also found in dry localities. Only sterile specimens have been found.

4. *Hymenostylium curvirostre* (Ehrh.) Lindb.

Barbula curvirostris Lindb.

N. Iceland: Mývatn (Gr!.)!. W. Iceland: Reykholt (Gr!.)!, in both localities sparingly and also sterile. S. Iceland: Merkjáfoss (F.)!; Barkarstadr, fr.!; Holt, fr.!; Vestmannaey, fr.!

In S. Iceland the plant is no doubt common on faces of damp tuff-rocks. In several localities near Barkarstadr and Holt it occurred abundantly in clefts along rivers or in caves and in depressions in tuff rocks; it was usually richly in fruit, and associated with *Preissia comulata*, *Fegatella*, *Haplozia riparia*, etc. On "Kleven" on the island of Vestmannaey it grew on the face of a tuff rock, through which water was percolating, forming with *Haplozia riparia* large cushions which were saturated with water.

5. *Anoetangium compactum* Schwgr.

Pleurozygodon æstivus (Hedw.) Lindb.

"In Islandia" leg. Mörch! and figured in Flora Danica, tab. 1893, fig. 2, under the name of *Gymnostomum curvirostre*.

E. Iceland: Seydisfjörður, common!; Berufjörður, common!. W. Iceland: Grundarfjörður (H. J.)!; Hafnarfjörður (Gr!.)!; Esja!; Svinahraun!. S. Iceland: very common!; Vestmannaey!.

This plant is very common in S., SW. and E. Iceland, but it does not appear to occur in N. and NW. Iceland. It grows especially on damp

rocks, e. g. on rock-sides along waterfalls and in clefts, where it forms large cushions, often almost one square metre in size, of a peculiar verdigris colour. In the lava-fields of SW. Iceland it is one of the most frequent species on the walls of caves and the sides of clefts. It hardly ascends higher than about 300 metres above sea-level. It is almost always sterile. The only fruiting specimen was collected by Mörch, but no habitat is given.

6. *Weisia crispata* (Br. germ.) Jur.

SW. Iceland: Reykjavik, fr.! SE. Iceland: Hornafjörður!; SW. Iceland: Álafoss!.

Near Reykjavik it grew in crevices of basalt rocks associated with *Encalypta rhabdocarpa* and *Bryum elegans* var. *carinthiacum*. The fruit had just ripened on June 6, 1909. Near Hornafjörður also it grew in small crevices of basalt. Only sterile specimens have been found.

7. *Weisia viridula* (L.) Hedw.

S. Iceland: Vik, associated with *Brachythecium velutinum* (H. J.)! Vestmannaey, Helgafell!, on a humus-covered block of lava.

Only sterile specimens have been found.

The species is recorded by Mörch from Iceland, but no specimens of it are to be found in the collections.

8. *Weisia Wimmeriana* (Sendtn.) Br. eur.

N. Iceland: Hof near Eyjafjörður (O. D.)!, fr.

It grew there mixed with *Eurynchium diversifolium* on rocks coated with soil.

9. *Dicranoweisia crispula* (Hedw.) Lindb.

Very common all over Iceland.

Dicranoweisia crispula is one of those species which is of equal frequency in all parts of Iceland, both at the coasts and in the highlands, and at all altitudes up to the snow-line. In the low land it grows, like *Andreaea*, on dry stones and rocks, but like the latter, it descends to the ground on mountain heights where it forms, both on the ground or on blocks of rock, dense, jet-black cushions. It is almost always found in fruit.

Note. *Dicranoweisia cirrata* is recorded by Hornemann, but has undoubtedly been confused with *D. crispula*.

10. *Dicranoweisia compacta* (Schleich.) Schimp.

N. Iceland: Hof near Eyjafjörður (O. D.)!. Only sterile specimens have been found.

FAM. RHABDOWEISIIACEÆ.

11. *Cynodontium polycarpum* (Ehr.) Schimp.

Seydisfjörður (C. Hansen)!

This species together with the var. *strumiferum*, is recorded by Vahl, but has without doubt been confused with another species, probably a *Dicranum* or *Oncophorus*. Mörch also records both forms from Iceland, but of his specimens in the Botanical Museum in Copenhagen some are *Dicranum Starckeii*, and some are *Ceratodon purpureus*.

Cynodontium gracilescens var. *tenellum* is recorded by Carrington from Akureyri, but has undoubtedly been confused with another species.

12. *Dichodontium pellucidum* (L.) Schimp.

Very common everywhere on damp ground.

This plant is most widely distributed in the lowlands and is found there everywhere on damp ground, both in bogs and on gravelly soil along streams, and also on soil-covered rocks. In the lowlands it usually grows mixed with all kinds of other mosses in their tufts and is, as a rule, low in growth and short-leaved. On rocks near the water, where it is also frequent, more vigorous forms occur in unmixed tufts, 2—4 cm. high. At higher levels it occurs more sparingly, but is nevertheless frequently found up to about 600 metres above sea-level. Only sterile specimens have been found.

FAM. AONGSTRÆMIACEÆ.

13. *Aongstræmia longipes* (Sommerf.) Br. eur.

E. Iceland: Hornafjörður!; Hof!; Seydisfjörður!; Vallanes!. N. Iceland: Akureyri (O. D.!); Husavik!; Vidimyri!; the Tverá!; Dettifoss!; Stadr near Hrutafjörður!. NW. Iceland: Ármuli!. W. Iceland: Haukadal!; Lundur!; Álafoss!. S. Iceland: Breidabolstadr!; Barkarstadr!; Seljaland!.

This species is doubtless common everywhere, but is often overlooked on account of its minute size. It grows on damp ground, most frequently as single specimens scattered among other mosses; more rarely, as for instance near Hornafjörður and Breidabolstadr, abundantly on peat along ditches. Near Lundur it grew abundantly associated with *Dicranella Schreberi*, *Bryum lacustre*, *Dichodontium* and other species in places where the peat had been pared off.

In the majority of the cases the specimens were not found until the material brought home had been investigated, because in habit they exactly resemble the tiny *Pohlia*-forms of wide occurrence, or a small, sterile *Anomobryum*.

On boggy ground it was usually collected together with *Dichodontium pellucidum*, *Oncophorus Wahlbergii*, *Meesia trichoides*, *Bryum* spp., etc. On gravelly soil near Stadr it was found associated with *Dicranella crispa*, *Didymodon rubellus*, *Blasia pusilla* and *Haplozia atrovirens* and in several places with *Distichium inclinatum*. It occurs both in the low

lands and up to 500–600 metres above sea-level. Near Akureyri it was found on a damp flat at about 500 metres. Near Barkarstadr it occurred abundantly on boggy ground at about 530 metres, and near Seljaland it was also frequent at an altitude of about 500 metres on a moss-grown gravelly flat. Only sterile specimens have been found.

FAM. DICRANACEÆ.

14. *Oncophorus virens* (Sw.) Brid.

Very common on damp ground. It grows both on wet humus-covered rocks and in bogs, and also on damp gravelly ground, sometimes as unmixed tufts and sometimes mixed with other mosses; it is of equal frequency at all altitudes as far upwards as 600–700 metres. It often occurs in great quantities and usually fruits richly. In the lower districts the fruit ripens about July 1st. In S. Iceland this species is either wanting or rare in the lowlands up to a height of about 300 metres (it has not been found on Vestmannaey), but from this height up to the snow-line it occurs abundantly in bogs.

Var. *serratus* Br. eur. occurs occasionally on wet rocks.

15. *Oncophorus Wahlenbergii* Brid.

One of the most commonly occurring mosses; it is found everywhere in damp localities just like *O. virens*. It is very common especially in bogs, except in S. Iceland where, like *O. virens*, it has its distribution from an altitude of 300 metres upwards.

Var. *β compactus* (Funch) Br. eur. E. Iceland: Skreiddal!; Seydisfjörður!. It grew in both localities on knolls in bogs.

Var. *elongatum* Hagen. W. Iceland: Nordredalur!. It grew there on boggy ground in association with *Sphagnum teres*, *S. rubellum* and *S. fimbriatum* in loose tufts about 6 cm. high.

Although typically developed forms of *Oncophorus Wahlenbergii* and *O. virens* differ so widely from each other that they are not likely to be confused, yet so many transitional forms occur, especially in Alpine habitats, that very often it is a matter of opinion to which species such a form should be referred. On the same plant leaves may be found which, as regards the cells of the leaf-base, resemble sometimes *O. Wahlenbergii* and sometimes *O. virens*; also the leaf-margin is more or less recurved or plane.

16. *Dicranella squarrosa* (Starke) Schimp.

E. Iceland: Seydisfjörður!; Skorastadr (H. J.)!. N. Iceland: Husavik!; near Eyjafjörður (O. D.)!, fr.; Lækjarmot!. NW. Iceland: Very common!. W. Iceland: Vogur (H. J.)!; Esja!; Reykholtalur!. S. Iceland: Holt!.

This plant grows almost always in water, especially on inundated gravelly ground by streams, on stones and in moss bogs, more rarely on wet marshy ground. In NW. Iceland it is one of the mosses of most frequent occurrence being found in abundance associated with

Philonotis seriatata, *Oncophorus Wahlenbergii*, *Scapania uliginosa*, *Haplozia cordifolia* and *Chiloscyphus polyanthus* var. *fragilis* on inundated gravelly ground up to about 300–400 metres above sea-level. In N. Iceland it is also rather common. Near Seydisfjörður it was found only at a height of about 300 to 500 metres above sea-level, but was common there in small streams associated with *Scapania undulata*, *Hyprum ex-annulatum*, *Haplozia cordifolia*, etc. In Reykholtalur this species was found in several places near hot springs, even on stones in warm water with a temperature of 30°. In SW. and S. Iceland it occurs rarely and more sparingly; near Holt it grew in several places at an altitude of 150–600 metres.

The plant is almost always found sterile. One specimen collected by O. D. near Hof in Eyjafjörður (12. 6. 1897) bore a few capsules which had thrown off their lids. The ♂ plant was found only near Bæir in NW. Iceland growing in low tufts, about 1 cm. high.

17. *Dicranella Schreberi* (Sw.) Schimp.

Anisothecium crispum (Schreb.) Lindb.

N. Iceland: Hof near Eyjafjörður (O. D.)!; Akureyri ♀!. W. Iceland: Lundur!.

Near Akureyri it grew in damp, peaty ground immediately north of the town and near Lundur, associated with *Bryum lacustre*, *Aongstromia longipes* and *Dichodontium pellucidum*, on a wet flat from which the peat had been pared off.

18. *Dicranella crispa* (Ehrh.) Schimp.

Very common on damp ground, both on peat and on sandy or gravelly soil by streams. It occurs only in the lowlands, and has hardly been found higher than at an altitude of about 200 metres. Fruit is always present in abundance and ripens about August 1st. At this time also the setæ of the capsules of the ensuing year have reached their full length.

Note. *Dicranella heteromalla* is recorded by Zoëga and Hornemann from Iceland, but was undoubtedly confused with another species.

19. *Dicranella subulata* (Hedw.) Schimp.

Dicranella secunda (Sw.) Lindb.

Iceland (Mörch)!, some of the specimens are correctly determined, some must be referred to *Ditrichum homomallum*. Krisuvik (Stp.)!. N. Iceland: Husavik!. NW. Iceland: Kaldalon!; Gnupsdalur near Dýrafjörður!. Moreover, Grönlund records it from Hvammur and Thingvellir, but both specimens are wrongly determined, being *Dicranella crispa* and *Dicranum Blyttii*.

This species was collected in small quantities only, but everywhere in fruit. Near Husavik it grew on peat, and on July 11, 1909 it bore

both quite young capsules and also old lidless capsules. In Gnupsdalur it grew along the banks of streams with *Scapania subalpina* and *Cephalozia bicuspidata*.

20. *Dicranella cerviculata* (Hedw.) Schimp.

Iceland: (Mörch)!. NW. Iceland: Stadr on Snæfjallaströnd (Stp.)!; Dýnjandi!. W. Iceland: Borgarnes!; Kollafjörður!; Reykjavík (Gr!;!). S. Iceland: Thjorsá (Stp.)!.

The plant was found everywhere in fruit. Near Borgarnes and Reykjavík the fruit was almost ripe at the beginning of August. It grows on peat, especially on the rather dry margins of turf pits and ditches and occurred abundantly especially in several places near Reykjavík.

21. *Dicranum fulvellum* (Dicks.) Sm.

Collected in Iceland by Mörch (no doubt near Middalur) and figured in Flora Danica, tab. 2002, under the name of *D. Mörchianum* Hornsch. S. Iceland: Holt!; Seljaland!; Thingvallhraun!. SW. Iceland: Svinahraun!.

This species is recorded by Grönlund from Svinaskard and Thingvalla, but the specimens from both localities are wrongly determined, being really *D. falcatum* and *D. Blyttii* respectively.

Dicranum fulvellum has been only found in the south-western part of Iceland, where it appears to be frequent. In Svinahraun, where the altitude hardly exceeds 300 metres, it was found rather sparingly (June 3rd) on the top of lava-blocks, in fruit which was almost ripe. On Eyjafjall it occurred in several localities above Holt and Seljaland at an altitude of 300—700 metres. It grew either on blocks of basalt or more rarely on gravelly ground in company with *Gymnomitrium concinatum*. At the end of July the fruit was ripe everywhere, and generally the capsules had thrown off their lids.

22. *Dicranum Andersonii* (Wich.) Schimp.

SE. Iceland: Hof!; coastal cliffs near Alftafjörður!. S. Iceland: Holt!; Vestmannaey!; Thingvellir!.

Near Hof it occurred rather commonly on low basalt ridges, where it usually grew in crevices in small cushions about 3 cm. high. Here the fruit had just ripened on June 15th and the lids still persisted. Near Holt it was found rather frequently on tuff rocks up to a height of about 300 metres. Thus, it grew abundantly, for instance on the vertical northern face of a tuff rock sometimes in small tufts, sometimes mixed with *Grimmia apocarpa*, *Pogonatum urnigerum*, *Pohlia grandiflora*, *Anthelia nivalis* and *Gymnomitrium concinatum*. On Vestmannaey the plant grew abundantly on blocks of lava lying on the slope of Helgafell. It occurred there everywhere in small scattered tufts associated with *Grimmia apocarpa*, *Rhacomitrium sudeticum*, *R. fasciculare* and *Andreea petrophila*. The fruit was ripe on July 5th; a few had thrown off their lids.

In Iceland *Dicranum Andersonii* is a decidedly lowland plant, which is probably widely distributed in the southern and south-eastern parts of the country. It occurs especially near the coast; in the interior of the country it has been found only near Thingvellir, where it grew very sparingly on a lava block in company with *D. fulvellum*, which it resembles in the fact that the peristome teeth are wide-spreading when dry. *Dicranum Andersonii* is however easily distinguished by its shorter seta and by the extremely thick-walled cells of the capsule-walls and by the absence of stomata.

23. *Dicranum falcatum* Hedw.

E. Iceland: Lonsheidi!, at an altitude of about 400 metres; Berufjörður!. N. Iceland: Ljosavatnsberg!. NW. Iceland: Dýrafjörður!; Ísafjörður!. W. Iceland: Snæfellsnes: Saxarhol (H.J.)!; Fróðarheidi (H.J.)!; Reynivellir (Grl.)!; Svinaskard (Grl.)!; Kolvidarhol!; Esja!. S. Iceland: Holt!; Seljaland!. The plant is recorded by Mörch from Iceland and figured in Flora Danica, tab. 2003, but Mörch's specimens in the Botanical Museum in Copenhagen belong to *Dicranoweisia crispa*.

Dicranum falcatum is a plant characteristic of the damp gravelly flats of mountain heights, where it often occurs abundantly in large, compact, rounded cushions in the neighbourhood of patches of snow. Usually it is not met with until an altitude of about 600 metres; near Kolvidarhol, however, it was common even at an altitude of about 400 metres. This species is very common in NW. and in S. Iceland and occurred also abundantly on Ljosavatnsberg. It is probably common everywhere on mountain heights, but, as for instance in E. Iceland, it has only been collected scantily, as its habitats are snow-covered in June when that part was explored.

The fruit, which is always present abundantly, ripens about the middle of July.

24. *Dicranum Blyttii* Schimp.

Dicranum Schisti (Gunn.) Lindb.

E. Iceland: Hamarfjörður!. N. Iceland: Reykjaheidi!; Vidvik (P.S.)!; Hof (O.D.)!. NW. Iceland: Patreksfjörður (Wiinstedt!); Gláma (St.)!, common on mountain heights!. W. Iceland: Øxarrhyggur!; Svinahraun!; Hafnarfjörður!. S. Iceland: Seljaland!, from an altitude of 350 metres upwards; Holt!, common on mountain heights; Thingvallahraun!.

This species is common, at any rate in NW. and SW. Iceland, while it has been found but scantily in E. Iceland and only in a few localities in N. Iceland. But the same is probably the case here as mentioned for *Dicranum falcatum*, that its habitats, at the time when E. Iceland was explored (June 1909), were covered with snow.

Dicranum Blyttii belongs to the Alpine region and is not met with until an altitude of 300–400 metres. Near Hamarfjörður, however, it grew in the lowlands on rocks near the coast. It grows partly on stones and partly on gravel, and is especially frequent at a height of 600–800 metres, both on gravelly flats soaked by the melting snow,

and on scattered blocks of rock. It often forms there extensive, blackish-green or almost black cushions, 2—3 cm. deep.

In lava-fields it occurs associated with several other Alpine species at the bottom of ravines, as on Reykjaheide (at an altitude of about 300 metres), in Thingvallhraun, where it was rather common on fallen blocks in ravines (Gjá), and near Hafnarfjörður, where it was also rather frequent in lava-clefts. In Svinahraun it grew abundantly on damp ground in a large depression at the edge of the lava-field.

The leaves usually spread erectly, more rarely, for instance in plants from Thingvellir, they are secund. The fruit ripens almost at the same time on mountain heights and in the lava-fields, viz. at the end of July. Near Thingvellir it was found on July 29th with fully ripe capsules, some of which had thrown off their lids.

25. *Dicranum Starckeii* Web. et Mohr.

"In Islandia" (determined by Mörch as *Dicranum polycarpon*).

Widely distributed all over Iceland.

This species is most widely distributed on damp gravelly flats from an altitude of about 400 metres upwards to the snow-line and is often there, especially from about 400—600 metres, the most abundant constituent of the vegetation, growing in extensive, continuous mats, 2—3 cm. deep. It occurs however also on stones and damp rocks. It is found more scantily in the more low-lying parts of the country, although, especially in NW. and N. Iceland, it is frequent, mixed with other mosses, on gravelly ground by streams. In the southern part of the country it does not appear to descend to a lower level than 300—400 metres.

Like *Dicranum Blyttii* this species grows also in lava-clefts, and it was common on fallen blocks both near Hafnarfjörður and Thingvellir. The plants from these localities were often 5—6 cm. high, with longer leaves, in which feature they approached very closely to *D. molle*.

The direction of the leaves varies considerably, orthophyllous forms are the most frequent, especially on the ground; highly drepanophyllous forms occur more particularly in drier localities, for instance on rocks.

Fruit is almost always present. The majority of the specimens collected (June—July) had old, empty capsules, and also young green ones or half-ripe ones which probably ripen late in the summer.

26. *Dicranum molle* Wils.

D. arcticum Schimp. *D. glaciale* Berggr.

E. Iceland: Seydisfjörður!, at an altitude of about 200 metres. N. Iceland: Akureyri!. NW. Iceland: Dýrafjörður!; Sugandafjörður!; Isafjörður!; Kaldalon!; Dýnjandi!. W. Iceland: Snæfellsnes, Mafahlid (H. J.)!, at an altitude of about 300 metres; Budahraun (H. J.)!; Dalasýsla, Vig-hólsstadir (H. J.)!, 550 metres alt.; Olafsvig (Mörch)!; Svinaskard (F.)!; Esja, Mödruvellir!. at an altitude of about 450 metres; Hafnarfjörður!. S. Iceland: Thingvallhraun!.

This species is also recorded from several localities by Grönlund,

but the specimens in the Botanical Museum are wrongly determined; most of them must be referred to *D. Starckeii* or *D. angustum*.

Dicranum molle usually grows on damp gravelly ground on mountain heights. In NW. Iceland it is one of the most commonly occurring mosses on rocky flats, and is common down to about 200 metres above sea-level; but also frequently descends as far down as the bottom of the valley. It grows both on gravelly flats soaked by melting snow and on damp slopes; also on lower levels on heathy soil, with other *Dicranum* spp. (*D. scoparium* and *D. fuscescens*), among *Vaccinium*, *Empetrum*, etc., in large tufts which are usually closely interwoven with *Lophozia lycopodioides*, *L. Kunzeana*, *L. quinquedentata*, *L. Floerckei*, *L. ventricosa* and other Hepaticæ. Near Möðruvellir it grew partly on damp gravelly ground, partly intermixed in abundance in *Racomitrium hypnoides*-heaths; in this latter locality also it was mixed with *Lophozia* spp.

In lava-fields it usually grows in company with *D. Starckeii*, commonly, as for instance in the clefts near Thingvellir, in cushions as much as 10 cm. deep. The plants from the latter locality and from Hafnarfjörðurhraun are sometimes not quite typical and approach so closely to *D. Starckeii*, that they can hardly be distinguished. The leaves are sometimes orthophyllous, sometimes drepanophyllous. The fruit, which is always present abundantly, ripens during July. In the district of Isafjörður, however, ripe fruit was frequently found as early as in the latter days of June.

27. *Dicranum Bonjeani* de Not.

D. palustre Br. eur.

SE. Iceland: Hornafjörður!; Lon!. N. Iceland: near Eyjafjörður (O. D.)!. W. Iceland: Dalasýsla: Ketilstaðr (H. J.)!; Reykholtalur (Gr!.); Reykjavík!.

The plants from all the above-mentioned localities agree exactly with *D. Bonjeani*, but being quite sterile they cannot be determined with perfect certainty. Bog-forms of *Dicranum scoparium* have often erect leaves, slightly undulate at the apex, and are then extremely difficult to distinguish from *D. Bonjeani*. This species grows in bogs, usually on knolls, and is common around Reykjavík and near Hornafjörður.

Note. In several older lists *Dicranum undulatum* is enumerated as found in Iceland by Mörch and is also recorded by Grönlund from Reykholt and Reykjavík, but all the specimens in the herbaria must either be referred to *D. scoparium* or *D. palustre*.

28. *Dicranum angustum* Lindb.

E. Iceland: Hornafjörður!; Berufjörður!; Lon!; Hof!. N. Iceland: Mývatn (Gr!.; determined as *D. arcticum*)!; Staðr near Hrutafjörður!. NW. Iceland: Dýnjandi!. W. Iceland: Stykkisholmur!; Reykjavík!. S. Iceland: Asolfskálaheidi near Holt!, at an altitude of about 400 metres.

This species is no doubt widely distributed over the whole of Iceland; it is, at any rate, rather common in E. and SW. Iceland, where

it often occurs abundantly. It grows on wet boggy ground in loose tufts as much as 6 cm. high, either pure or mixed with *Sphagna* and *Hypnum stramineum* and interwoven with Hepaticæ such as *Lophozia quinqueidentata*, *Scapania irrigua*, *Cephalozia pleniceps*, etc. Only sterile specimens have been found.

This species is most widely distributed in the lowlands and has only once been collected at an altitude of 400 metres on Asolfskálaheidi, where it grew plentifully in a bog.

Hagen (Musci Norv. Borealis, p. 22) states that *D. angustum* differs from all nearly allied species, and especially from *D. scoparium*, in having thin-walled cortical cells; but this distinction does not suffice as regards bog-forms of *D. scoparium* as in the latter species all transitional stages are found from the thin-walled, hyaline cortical cells of plants from wet ground to the thick-walled, brown cells of xerophilous forms.

29. *Dicranum majus* Smith.

NW. Iceland: Dýrafjörður!; Sugandafjörður!; Isafjörður!. W. Iceland: Neshraun (H. J.)!; Budahraun (H. J.)!.

In the two habitats in W. Iceland, both of them on Snæfellsnes, the plants were collected in depressions in the lava-field. In NW. Iceland, where it is commonly distributed, it grows on the ground on slopes covered with birch coppice, *Vaccinium*, etc., as far upwards as about 300 metres above sea-level.

The majority of the plants collected have slightly secund leaves and entirely resemble *D. scoparium* in habit. A vigorous form with strongly falcate leaves was found in a birch coppice near Dýrafjörður at an altitude of about 150 metres. Only sterile specimens have been found.

30. *Dicranum scoparium* (L.) Hedw.

Very common.

D. scoparium is most widely distributed in the more low-lying parts of the country up to a height of about 400–500 metres, but also ascends frequently to about 700 metres above sea-level. In S. Iceland it appears to be more rare and, as for instance on Fljótshlíð and south of Eyjafjall, was only found in a few localities and very scantily. It grows both on rather dry and on damp ground, and also on rocks and on knolls in bogs, and varies considerably. Orthophyllous forms are the most common, especially on damp ground, while more or less distinctly drepanophyllous forms grow by preference in dry localities, for instance in lava-fields and on rocks. In bog-forms the leaves are slightly undulate at the apex, in which feature it approaches *D. Bonjeani*. The leaf-apex, especially in orthophyllous forms, is usually short and broad, and faintly toothed, or even quite entire, at the margin, at the same time the lamellæ on the back of the leaves develop more slightly or disappear almost entirely. Such forms agree well with var. *integrifolium* Lindb.

Fruit is found rather rarely; in Nordredalur it was fully developed on August 2nd, but was still green.

31. *Dicranum fuscescens* Turn.

Iceland (Wiinstedt, determined by Berggren as *D. Scottianum*). NW. Iceland: very common!. W. Iceland: Nordredalur!.

In NW. Iceland *D. fuscescens* is the most frequently occurring species of this genus and is very common from the bottom of the valley up to a height of 400—500 metres. It is most widely distributed from about 100 to 300 metres on somewhat damp slopes covered with *Vaccinium-Empetrum* heath, where it often constitutes the bulk of the Bryophyte vegetation in association with *D. molle*, *D. scoparium* and occasionally, *D. majus*. It is also common on the top of knolls in bogs. The densely matted tufts, which are as much as 10 cm. high, are almost always interwoven with Hepaticæ, especially *Lophozia* spp., *Cephalozia pleniceps*, *C. bicuspidata* and *Ptilidium ciliare*. In Nordredal it was growing in birch coppices in company with *Hylocomium* spp.

The fruit, which occurs rather frequently, was quite green even in the beginning of July.

All the Iceland specimens differ from the typical form and, more or less, especially approach *Dicranum congestum* without, however, forming any real transitional form to the latter. As a rule the leaf-nerve occupies about $\frac{1}{4}$ the width of the leaf-base, but occasionally $\frac{1}{5}$ — $\frac{1}{6}$ only. The cells of the leaf-apex are usually quadrate or roundish, mixed with numerous ones that are irregular in form; rarely, in the main, shortly rectangular, in which feature it approaches var. *angustifolium* Arn. et Jensen; most frequently arranged more or less distinctly in rows; papillose at back, more rarely almost smooth, but in the same tuft or even on the same stem rather considerable variations occur as regards the development of the cell-tissue and the papillæ of the leaves.

32. *Dicranum congestum* Brid.

Very common in E. and N. Iceland and probably also in W. Iceland, somewhat rarer in S. Iceland. It appears to be quite absent from NW. Iceland and to be replaced there by *D. fuscescens*.

It grows both on a dry and on a somewhat damp substratum, on earth and humus-covered stony slopes and on the top of knolls in bogs, and extends as far upwards as to the snow-line, for instance near Akureyri up to about 900 metres above sea-level. In S. Iceland it has not been found in the low land, but plentifully in several places on the rocky flat, for instance near Barkastadr, 500 metres above sea-level.

Var. *subspadiceum* Arn. et Jensen occasionally occurs in localities similar to those of the type, but transitional forms are of more frequent occurrence.

Var. *flericaule* (Brid.) Br. eur. N. Iceland: Ljosavatn!. in *Betula-nana* heath; Hof (O. D.)!.

Only sterile specimens have been found.

Dicranum congestum is so variable a species that it is hardly possible to find two plants which are exactly alike. The nerve occupies $\frac{1}{6}$ — $\frac{1}{10}$ the width of the leaf at its base, usually $\frac{1}{8}$ — $\frac{1}{9}$. The leaf-cells

are irregular in form more or less far down the leaf, sometimes far below the middle, sometimes only at the leaf-apex itself; slightly or hardly porose, occasionally strongly porose in the lower half of the leaf, more rarely to near the apex, in the last case the walls are strongly incrassate.

Dicranum brevifolium Lindb. is recorded from Vatnsdalsfjall (Grl., Tillæg til Islands Kryptogamflora, Bot. Tids., 20), but the plant from the latter locality is only a form of *D. congestum* in which the irregularly shaped cells are strongly incrassate and extend down below the middle of the leaf. Such forms, which, as a rule, are also distinguished by very strong nerves, have been found in several localities, for instance near Berufjörður and about Eyjafjörður. The true *D. brevifolium*, which is distinguished by its shorter leaves, crisped when dry, and its thin-walled cells, which are in a great measure quadrate and in rows, has not been found in Iceland.

33. *Dicranum spadiceum* Zett.

W. Iceland: Hvitidalur (H. J.)!. E. Iceland: Hornafjörður!; Seydisfjörður!. N. Iceland: Hof (O. D.)!; Vatnsdalsfjall (St.)!.

Grows on a damp substratum, especially on knolls in bogs. Only sterile specimens have been found.

34. *Dicranum elongatum* Schleich.

"In Islandia" Mörch! (fr.). N. Iceland: By Hrutfjörður!. NW. Iceland: Dýnjandi!; Hesteyri!. W. Iceland: Stykkisholmur!. This species is also recorded from some localities by Grönlund, but the specimens in the collections are wrongly determined, being *D. Starckeii*, and others.

D. elongatum grows everywhere on wet, boggy ground. By Hrutfjörður it was common on knolls in bogs along the eastern side of the fjord from Stadrbakki to Stadr, and it was also frequent in bogs near Stykkisholmur.

All the specimens collected were quite typical. The nerve was about $\frac{1}{4}$ the width of the leaf at its base. With the exception of the specimen found by Mörch only sterile specimens have been collected.

Note. According to Gliemann, *Dicranum montanum* was found in Iceland by Mörch, but no specimens of it are to be found in the collections, and the record of this species is undoubtedly due to an erroneous determination.

35. *Campylopus Schimperii* Milde.

N. Iceland: Geitaskard!. E. Iceland: Hornafjörður!; Lon!; Berufjörður!. W. Iceland: Reykjavík!; Esja (Grl.)!. S. Iceland: Breidabolstadr!.

Commonly distributed in South-western and South-eastern Iceland on damp ground in bogs, where it forms compact cushions, 2–3 cm. deep. It has only been found in the low land.

36. *Campylopus flexuosus* (L.) Brid.

N. Iceland: Mývatn (Grl.)!; Reykir near Svinavatn (Grl.)! W. Iceland: Near hot springs in Reykholtalur: Deildatunguhver (Grl.;!) Skribla (Grl.)!; Hagindishver!, etc.

This species has been found only on steaming clayey flats near hot springs in North and West Iceland. In Reykholtalur it is frequent on a warm substratum, and was found, for instance near Deildatunguhver, in large mats, about 2 cm. deep, on warm clayey flats with a temperature of about 40° just below the surface.

37. *Campylopus fragilis* (Dicks.) Br.-eur.

S. Iceland: Laugaráshver near Skálholt.

It grew there on warm clayey flats close to the outlet from the spring.

38. *Trematodon ambiguus* (Hedw.) Hornsch.

W. Iceland: near Borgarnes!.

It grew there rather scantily on damp peaty soil by the road, in company with *Bryum inclinatum*, *Pogonatum nanum*, *Scapania curta*, etc. The fruit had just ripened on Aug. 2nd, but the lids had not been thrown off.

Note. *Leucobryum glaucum* is recorded by Vahl and Horne-mann as found in Iceland, but neither the name of the finder nor the habitat is given. No specimens of this species are to be found in the collections.

FAM. FISSIDENTACEÆ.

39. *Fissidens bryoides* (L.) Hedw.

N. Iceland: Hof near Eyjafjörður (O. D.)! S. Iceland: Krokur (H. J.)! Almannagjá!.

In Almannagjá it grew very scantily among other mosses on soil-covered stones at the bottom of a lava-cleft. Near Hof it grew on damp ground by a waterfall. The fruit, on the specimens from both localities, was ripe when collected (June 12).

40. *Fissidens osmundoides* (Sw.) Hedw.

Common on damp ground in bogs, at the base of rocks, in rock-clefts, etc., sometimes in low, dense tufts, sometimes mixed with other mosses. The plants are almost always found sterile. Only in Reykholtalur, where it grows very abundantly on warm, boggy ground, has it been collected in fruit. It is most widely distributed in the lowlands up to about 300 metres above sea-level, but it may occur, although scantily, as high as about 500—600 metres.

41. *Fissidens adianthoides* (L.) Hedw.

N. Iceland: Hof near Eyjafjörður, fr. (O. D.)!. W. Iceland: Kleppjarnsreykir (Grl.); Laugarnir near Reykjavík (Grl.)!; bog near Reykjavík, fr.!; Kollafjörður!

Rare and scanty on boggy or warm ground.

Note. *Fissidens taxifolius* is recorded by Zoëga and Hornemann from Iceland (without finder, habitat or specimens in the collections) and by Grönlund from Mývatn; but Grönlund's specimen belongs to *F. osmundoides*.

42. *Fissidens decipiens* De Not.

W. Iceland: Sandur (H. J.)!; Hafnarfjörður!

This plant grew in both localities in lava-clefts, associated with *Lejeunea serpyllifolia*.

FAM. SELIGERIACEÆ.

43. *Blindia acuta* (Huds.) Br. eur.

Very common on wet rocks in or by rivers and waterfalls up to about 400–500 metres above sea-level, occasionally also on the ground and often in great abundance. The fruit, which is almost always present, ripens in the beginning of July.

At a greater altitude it occurs more scantily, but may nevertheless be met with as far upwards as 600–700 metres.

FAM. DITRICHACEÆ.

44. *Ceratodon purpureus* (L.) Brid.

Common on rocks, lava-flats, sandy soil, peat, etc. especially in N. and NW. Iceland, and on lava-flats in the interior of the country. It is less frequent in E. and S. Iceland. The fruit, which is usually present, ripens in the first half of July.

It varies considerably, especially in leaf-form. Forms with shortly pointed or almost obtuse leaves (var. *brevifolius*) are the most frequent.

45. *Ditrichum tortile* (Schrad.) Lindb.

E. Iceland: Seydisfjörður!, sterile.

It was growing there on damp gravelly soil along a river, interspersed in a Hepaticæ-mat formed by *Alicularia scalaris*, *A. geoscypha*, *Anthelia Juratzkana*, *Lophozia ventricosa*, etc.

46. *Ditrichum nivale* (C. M.) Limpr.

E. Iceland: Berufjardarskard!, at an altitude of about 500 metres, fr.

The plant was growing very scantily in a cushion of *Anthelia Juratzkana*.

The entire height of the plant was about 6 mm. The seta was about 5 mm. high. The capsules were, without the lid, about 0.5 mm. long.

47. *Ditrichum homomallum* (Hedw.) Hampe.

Fl. Dan. tab. 2688, ex Islandia leg. Mörch. E. Iceland: Vestdalur near Seydisfjörður!, sterile. N. Iceland: Hof near Eyjafjörður (O. D.!), sterile. W. Iceland: Reykjavík (Gr.!), fr.; hot spring near Grafarbakki (F.!), sterile; Hafnarfjörður, at the bottom of a lava cave!, sterile. S. Iceland: Geysir! ♀.

Around Reykjavík it was rather common along the side of ditches. There the fruit was ripe on August 7th. Near Geysir it occurred in extensive mats, about 1—2 cm. deep, on warm clayey flats with a temperature of 35—40°.

48. *Ditrichum flexicaule* (Schleich.) Hampe.

One of the most commonly occurring mosses; it is met with on almost every substratum and at all altitudes. It grows both on damp or soil-covered rocks and in bogs, where it especially occurs woven into the tufts found there, and on damp or on more dry gravelly soil, in lava caves, in grass fields, in heaths, etc.

This species varies considerably, especially as regards the length and direction of the leaves. Short-leaved forms (*f. brevifolia*) are frequent on more dry ground, where they form dense tufts with stiffly erect or slightly secund leaves. On damp ground and especially in sheltered localities, for instance among stones, or in clefts, the leaves become longer, often strongly secund, and the tufts higher and looser. Fruit it very rare. Near Seydisfjörður, in the beginning of July, the setæ had not developed to their full length and the capsules were barely formed.

49. *Sælania cæsia* (Vill.) Lindb.

Ditrichum glaucescens (Hedw.) Hampe.

E. Iceland: Breiddalur!; Hallormstadr!. N. Iceland: Vidimýri (Gr.!)!; several places near Eyjafjörður (O. D.!). W. Iceland: Husafell (Gr.!)!; Kalmanstunga (Gr.!)!; Gilsbakki!; Hafnarfjörður!; Esja!. S. Iceland: Skálholt!; common near Thingvellir!.

This species is rather common, especially in W. and SW. Iceland, in soil-filled rock and lava clefts, as a rule associated with *Mnium orthorrhynchum*, *Plagiothecium Roeseanum*, *P. pulchellum*, *Pohlia cruda*, *Distichium montanum*, etc.

In the wood by Hallormstadr it was growing on the ground in company with *Bartramia ityphylla*, *Pohlia cruda*, *Distichium inclinatum* and *Ditrichum flexicaule*. The fruit, which is almost always present, ripens in the middle or at the end of June. The plant has not been observed at a higher altitude than about 200—300 metres.

50. *Distichium montanum* (Lam.) Hagen.

Distichium capillaceum (Sw.) Br. eur.; *Swartzia montana* (Lam.) Lindb.

Very common all over Iceland.

Distichium montanum is one of the most widely distributed mosses in Iceland. It is found everywhere on almost every kind of substratum, with the exception of that which is very wet, from the bottom of the valley up to a height of about 500–600 metres above sea-level. At greater altitudes it is more rare, but may nevertheless be met with as far upwards as to the snow-limit, in sheltered localities among stones.

This species has its main distribution in the more low-lying regions where, either intermixed with other species or in unmixed tufts, it is hardly absent from any cleft or soil-filled rock-crevice, but it also occurs everywhere intermixed in the moss-covering at the bottom of grass-fields, in bogs, on rocks, etc.

The fruit, which is almost always present, ripens in the latter half of July.

51. *Distichium inclinatum* (Ehrh.) Br. eur.

Swartzia inclinata Ehrh.

E. Iceland: Vallanes!. N. Iceland: Near Dettifoss!; Husavik!; Hof near Eyjafjörður (O. D.)!; Öxnadalur!; Vidimýri!. NW. Iceland: Gnupsdalur in Dýrafjörður!.

It was also collected by Steenstrup, but no habitat is given. Grönlund records this species from Hafnarfjörður, but the specimens in the Botanical Museum belong to *Distichium montanum*.

This plant was only found in the northern half of Iceland, where it occurred in many places from Vallanes in the east to Dýrafjörður in the north-west, and especially in North Iceland proper. It grows as a rule on damp ground, although not very abundantly, for instance along streams, associated with *Dichodontium*, *Didymodon rubellus*, *Hepaticæ*, etc. Near Vidimýri it was growing along the banks of streams, mixed with *Scapania curta*, *Lophozia Mülleri*, *Haplozia atrovirens*, *Dichodontium* and *Bryum pallens*; near Dettifoss on glacier-sand, in company with *Ceratodon purpureus* and *Aongstræmia longipes* and near Husavik on damp sandy soil, with *Aongstræmia*, *Dichodontium* and *Philonotis tomentella*. In several places it was collected on peaty soil in association with *Meesia trichoides*, *Catocarpium nigratum*, *Barbula rubella*, *Aongstræmia*, *Lophozia Wenzelii*, etc.

In North Iceland proper the fruit was almost ripe at the end of July.

52. *Bryoxiphium norvegicum* (Brid.) Mitten.

Eustichium norvegicum Br. eur.

S. Iceland: Krisuvik (Mörch)!; Thingvellir (Mörch)!; glacier originating from the Jökul (Stp.)!; Kolvidarhol!; Flokastadagil!; Barkarstadr!; Drángshlid!.

This species was only found in the south-western part of the

country, where it is common in many places and often occurs in enormous quantities. Mörch records that it grows in holes in the lava. Near Kolvidarhol it was found everywhere on tuff, from the farm (at about 250 metres) up to about 450 metres above sea-level; it was found in extensive mats, especially on the vertical or overhanging sides of the tumbled-down blocks, and in the interior of holes and clefts. It was most frequent on Fljótshlid and south of Eyjafjall. There it was growing in many places on the vertical sides of tuff-rocks in the ravines and on the fallen blocks, for instance in Flokastadagil near Breidabolstadr it covered long stretches of the perpendicular sides of a ravine, from a distance of a few cm. above the water-level of the river upwards, with a dark-green closely adhering mat in which almost no other mosses were intermixed. In this part of the country it has only been met with up to about 100 metres above sea-level. Only sterile specimens have been found.

Bryoxiphium norvegicum is the only Iceland moss which does not occur on the European continent or in the British Isles. Outside Iceland it has only been known to occur in a few localities in North America (Ohio, Kentucky and Wisconsin).

FAM. POTTIACEÆ.

53. *Pottia Heimii* (Hedw.) Br. eur.

Iceland (Mörch)!

E. Iceland: Hornafjörður!. N. Iceland: near Eyjafjörður (F.)!; Saudanes (St.)!; Grimsey (O. D.)!. NW. Iceland: Ármuli!. W. Iceland: Reykjavík (Gr.)!; Borgarnes!. S. Iceland: Vestmannaey!.

This species grows on sandy or muddy soil near the sea, and is probably commonly distributed along the whole coast in such localities. Around Reykjavík, on Vestmannaey and near Hornafjörður it was common, and was frequently found also on soil-covered rocks and in rock-clefts close to the sea.

The fruit ripens about July 1st; on Grimsey the fruit was fully ripe on July 14th, but the lids had not been thrown off. Near Ármuli it was hardly ripe during the first days of July.

54. *Pottia latifolia* (Schwägr.) C. M.

N. Iceland: Hof near Eyjafjörður (O. D.)!; Ós (O. D.)!, with ripe capsules on June 17th.

Note. *Pottia truncatula* and *P. lanceolata* are enumerated in older lists as found in Iceland, but no specimens of these species are to be found in the collections, and their occurrence in Iceland is very improbable.

55. *Didymodon rubellus* (Hoffm.) Br. eur.

Barbula rubella (Hoffm.) Mitten.

Very common everywhere on a more or a less damp substratum, in rock-clefts, on the ground, on rocks and gravelly soil by rivers, in bogs, etc. It grows sometimes in unmixed tufts and sometimes inter-

mixed with other mosses, and as a rule sets fruit, which ripens late in August or early in September. It is most frequent in the low land up to about 300 metres above sea-level, but is also met with, although scantily, and often sterile, as far upwards as to the mountain heights, for instance on Isaffjardarheidi, about 600 metres above sea-level.

Forms which must be referred to var. *brevifolia* Lindb. et Arnell occur commonly together with transitional forms to the type. Near Seydisfjörður the variety was found abundantly in reddish brown, dense tufts, about 5 cm. high, in rock-fissures filled with soil.

Note. *Didymodon tophaceus* is recorded by Lindsay from Iceland, but no specimens are in the collections and the record is probably due to an erroneous determination.

56. *Didymodon rufus* Lorentz.

E. Iceland: Stafafell!; Geithellir!. N. Iceland: Stadr near Hrútafjörður!; Akureyri, at an altitude of 900 metres!. W. Iceland: Lundur! Breidabolstadr in Reykholtalur!.

The plant, which was only found sterile, grew in all the above localities in loose tufts, a few cm. high, on damp gravelly ground, as a rule rather scantily. Near Akureyri it grew scantily among *Sphaerocephalus turgidus* and *Racomitrium hypnoides*.

57. *Leptodontium flexifolium* (Dicks.) Hampe.

N. Iceland: Grimsey (O. D.)! (f. *compacta*).

Enumerated in Lindsay's list, but neither the name of the finder nor the habitat is given.

58. *Trichostomum littorale* Mitten.

Mollia littoralis (Mitten) Braithw.

S. Iceland: Helgafell on Vestmannaey, on blocks of lava!; Hafnarfjörður, in a lava cave!; on warm clayey flats near Reykjanæs light-house (Ostf.)!, associated with *Preissia*, *Riccia* and *Archidium*.

59. *Tortella inclinata* (Hedw.) Limpr.

Mollia inclinata (Hedw.) Lindb.

E. Iceland: Vallanes (H. J.)!.

60. *Tortella tortuosa* (L.) Limpr.

Mollia tortuosa (L.) Schranck.

Very common all over Iceland.

This species has its main distribution in the low land up to about 400 metres above sea-level. It appears to be rare everywhere at higher levels, and hardly ascends higher than about 600 metres. It grows

both on rocks and on earth. In lava-fields it is one of the most commonly occurring species, and grows there in enormous cushions on rock-sides in caves and clefts, in association with *Amphidium Mougottii*, *Anæclangium compactum* and *Grimmia torquata*. On rocks it grows on perpendicular faces, on soil-covered ledges, and in clefts. On the ground it is found especially where it is not too damp, for instance in grass-fields and on the top of knolls in bogs, usually intermixed in tufts of other mosses. At higher altitudes it rarely grows on rocks, but as a rule on gravelly ground or in bogs. Only sterile specimens have been found.

This species varies considerably in the size and length of the leaves. Forms from shady and protected localities, especially from lava-clefts, form very tall and loose tufts with exceedingly long and strongly crisped leaves.

61. *Tortella fragilis* (Drumm.) Limpr.

Mollia fragilis (Drumm.) Lindb.

Commonly distributed all over Iceland.

This species grows in localities similar to those of *T. tortuosa*, and often in company with the latter, but as a rule rather scantily. It usually occurs in unmixed tufts on soil-covered rocks and on somewhat damp ground, but only sterile specimens have been found. Around Reykjavik, for instance, it was common on knolls in boggy tracts which had been partially drained. In NW. Iceland it is rather rare, and has only been found in a few localities near Kaldalon.

62. *Barbula unguiculata* (Huds.) Hedw.

var. *cuspidata* (Schultz) Braithw.

S. Iceland: Vestmannaey!, on damp gravelly soil near the town. It has previously been collected here by an unknown finder (H. Jonsson believes by G. Brynjolfsen). W. Iceland: Saurbær near Hvalfjörður, at an altitude of about 100 metres, on soil-covered rocks. In both places only sterile specimens have been found.

63. *Barbula fallax* (Hedw.).

S. Iceland: Reykir ♀. W. Iceland: Saudlauksdalur (H. J.).

Var. *lævifolia* n. var.

In wide dense cushions, 2—3 inches deep, rusty brown in the interior, brownish green at the top. The lower leaves as in the type, the uppermost shortly pointed with rounded, broad and flat apex, into which the strong nerve runs out, widely revolute to near apex, with two deep plicæ at the base. Leaf-cells in form and size as in *B. fallax*, in the lower half of the uppermost leaves, however, more thin-walled, shortly rectangular; all quite smooth or, more rarely, indistinctly papillose. The innermost perichætil leaves ovate or widely lanceolate, with faint or indistinct nerves.

S. Iceland: Thorlákshver, on warm clayey ground.

Although this form differs somewhat from *B. fallax* in habit, in the smooth leaves with rounded apex, and in the divergent form of the perichætal leaves, yet there is hardly any doubt that it must be referred to this species. Setting apart the absence of papillæ the leaf-tissue is quite typical, and the form and the plication of the lower leaves are exactly as in *B. fallax*. It should be remembered that the occurrence on a warm substratum produces very divergent forms also in other mosses, e. g. *Philonotis*, *Catharinaea* and *Oligotrichum*. Near Reykir, *B. fallax* was collected both on stones by the river, in sand-



Fig. 1. *Barbula fallax* Hedw. a, Leaves of the plant from Reykir ($\times 20$). b, Leaves of var. *lævifolia*; c, perichætal leaves of same.

filled tufts about 2 cm. high, in a somewhat typical form, and on a warm, damp substratum. Plants from the latter locality form a transitional stage to var. *lævifolia*. It grew in somewhat loose tufts, 3–4 cm. high, which in colour and appearance agreed with var. *lævifolia*. The lowermost leaves are pointed, the uppermost rounded; the perichætal leaves are lanceolate, rounded, with rather faint nerve. The leaf-cells are distinctly papillose, sometimes as highly as in the typical form, sometimes much more faintly.

64. *Barbula cylindrica* (Tayl.) Schimp.

N. Iceland: Hof near Eyjafjörður (O. D.)! S. Iceland: Vestmannaey!; Ýtri Skogur (H. J.)!; Fljótshlid!; Holt!; Drángshlid!; Hornafjörður!. W. Iceland: Esja near Kollafjörður!.

This species occurred commonly, and often abundantly, on tuff-rocks in S. Iceland and on Vestmannaey. There it also grew abundantly on sandy soil and on lava blocks near the sea. In the other localities it was found but scantily. Fruit was collected only near Holt, where, at the end of July, both old and yet green capsules were collected from the same tuft.

65. *Barbula icmadophila* Schimp.

SE. Iceland: Hornafjörður!, in several places in small quantities.
 N. Iceland: Skagafjörður (Gr1)!; Hofsfjall near Eyjafjörður (O. D.)!.
 W. Iceland: Esja, at an altitude of 400 metres!.

This species has been collected everywhere only in small quantities, in cushions 1—2 cm. deep, on humus-covered rocks.

66. *Desmatodon latifolius* (Hedw.) Br. eur.

Tortula latifolia (Hedw.) Lindb.

E. Iceland: Djúpivogur!, common near the sea; Vallanes!; Hamar-fjörður!; Berufjörður!. N. Iceland: Husavik! at an altitude of about 400 metres; Reykjahlid!; Grimsey (O. D.)!; Stadr near Hrutafjörður!. NW. Iceland: Isafjörður!; Grunnavik!; Hesteyri!; Arngerdaeyri!; W. Iceland: Stykkisholmur!.

Var. *muticus* Brid.

Grimsey (O. D.)!; Reykjahlid!; Isafjörður!, 450 metres above sea-level. Found in all the localities together with the type.

In NW. Iceland *D. latifolius* is one of the most frequently occurring species, and the same appears to be the case in E. Iceland. It occurs especially near the sea on sandy soil or, also, on humus-covered rocks, and often abundantly. Near Vallanes it grew in masses on peat walls and on dikes around the farm, associated with *Encalypta rhabdocarpa*, *Tortula subulata*, *Ceratodon purpureus*, *Bryum argenteum*, *Bartramia ityphylla*, etc.

In N. Iceland this species occurs more sporadically. Near Husavik only a single little tuft was found on the top of Husavikurfjall; near Reykjahlid it was common in lava-fields, in places covered by a thin humus-layer, associated with *Ceratodon purpureus*, *Tortula ruralis*, *T. subulata*, etc., and near Stadr it grew on the peat walls of the farm exactly as it grew near Vallanes. From SW. and S. Iceland this species appears to be quite absent, and in W. Iceland it was only found near Stykkisholmur, where it was found abundantly on earth and rocks along the shore.

It is only by exception that *Desmatodon latifolius* has been found at higher altitudes. Near Isafjörður it occurred here and there on the rocky flat up to a height of about 500 metres, for instance on a stony slope 450 metres above sea-level, associated with *Bryum elegans*, *Bartramia ityphylla*, *Pohlia commutata*, *Scapania curta* and *Encalypta rhabdocarpa*. The fruit, which was present everywhere in abundance, ripens at the end of June.

67. *Desmatodon cernuus* (Hüb.) Br. eur.

Tortula cernua (Hüb.) Lindb.

N. Iceland: Hof (O. D.)!; Hjalteyri (O. D.)!.

On the plant from Hjalteyri the fruit had just ripened on September 5, 1897.

68. *Tortula obtusifolia* Schleich.

S. Iceland: Flokastagil on Fljótshlid!; Drángshlid!.

This very rare species was found in both places in very small cushions, only 5—6 mm. deep, with numerous capsules which were almost fully ripe in the latter half of June. In Flokastadagil it grew here and there on fallen blocks, especially in small fissures on the vertical rock-faces. Near Drángshlid it was found in small quantity on the dry faces of tuff-rocks in company with *Tortula muralis*, *Grimmia Doniana* and *Orthotrichum anomalum*.

69. *Tortula muralis* (L.) Hedw.

S. Iceland: Vestmannaey!; Drángshlid!.

The plant was found very scantily in both places on dry faces of tuff-rocks. On Vestmannaey it grew on a rock-face with a southern exposure, associated with *Grimmia maritima* and *Barbula cylindrica*; near Drángshlid it grew in association with *Grimmia Doniana* and *Tortula obtusifolia*.

70. *Tortula subulata* (L.) Hedw.

Commonly distributed over the whole of Iceland.

The plant grows almost exclusively in the low land up to about 300 metres above sea-level, and only in quite a few localities in S. Iceland has it been found at a higher level, for instance near Barkastadr at an altitude of 410 metres. It is most frequent in S. and E. Iceland; in N. and NW. Iceland it is somewhat less common, but has nevertheless been collected from a great number of places. It usually grows on a rather dry substratum, e. g. humus-covered rocks, in rock-clefts, on dikes and on peat walls of houses, mostly associated with *Bartramia ityphylla*, *Pohlia cruda*, *Encalypta rhabdocarpa*, *Brachythecium albicans* and other species. Fruit, which is always present, ripens in the end of June or in the beginning of July.

71. *Tortula mucronifolia* Schwgr.

Vestmannaey!.

It occurs here in localities quite similar to those of *Tortula subulata*, for instance on dikes, in sandy soil and on humus-covered rocks, and appears to be as frequent as this. The fruit was not yet quite ripe towards the middle of June.

72. *Tortula ruralis* (L.) Ehrh.

Commonly distributed over the whole of Iceland.

Tortula ruralis is a decidedly xerophilous species, and has, therefore, its widest distribution in the driest parts of the country. In the lava-fields in the interior, for instance around Mývatn, it occurs abundantly; in NW. Iceland it is also more frequent than in the other parts

of the country, especially E. Iceland, where it occurs but scantily in many districts.

It grows in sandy soil, upon soil-covered rocks and at the base of vertical rock-faces, and is most frequent in the low land. Near Akureyri it was found with ripe fruit (20. 7. 1909). Near Grunnavik in Jökulsfjörður it was found in fruit at an altitude of 270 metres. In Esja it has been collected up to about 420 metres above sea-level. Near Vallanes the fruit was ripe about July 1st. At the coast, near Reykjavik, it grew abundantly in large tufts which were quite filled with sand.

73. *Tortula aciphylla* (Br. eur.) Hartm.

T. norvegica (Web.) Wahlb.

NW. Iceland: Dýrafjörður!, at an altitude of 150 metres.

It grew there in cushions, about 2 cm. deep, on humus-covered rocks. The capsules were quite green on June 17th.

The leaf-form, nerve and leaf-hair in these specimens were quite typical, but the cells of the leaf-base were occasionally chlorophyllose towards the margin, forming a more or less distinct border, in which feature it approached *Tortula ruralis*.

FAM. GRIMMIACEÆ.

74. *Schistidium maritimum* (Turn.) Br. eur.

E. Iceland: Hornafjörður!; Hof!; Hamarfjörður!; Djúpivogur!. N. Iceland: Husavik!; Grimsey (O. D.)!. NW. Iceland: Common everywhere along the coasts!. W. Iceland: Stykkisholmur; Hafnarfjörður!; Reykjavik (Gr.); by Hvalfjörður (Gr.)!. S. Iceland: Vestmannaey!.

This plant doubtless occurs everywhere along rocky shores. It is, however, absent from, or only occurs scantily in, the interior of deep, narrow fjords. Thus, around Berufjörður it is very common towards the entrance of the fjord, near Djúpivogur, while it is entirely absent from the head of the fjord.

As a rule it grows only on rocks quite close to the sea, and up to a height of some 10 metres. More rarely, for instance near Djúpivogur and on Vestmannaey, it descends to the sandy ground at the foot of cliffs.

Fruit is almost always present abundantly.

75. *Schistidium apocarpum* Br. eur.

Grimmia apocarpa Hedw.

Subsp. *vulgare* (Chal.) Loeske.

Common over the whole of Iceland.

It grows, as a rule, on rather dry rocks, occasionally also in gravelly soil, but then rarely in any great abundance. It is most frequent

in the more low-lying parts of the country, but may, however, occasionally be met with upwards of 600 metres above sea-level.

76. *Schistidium apocarpum* Br. eur.

Subsp. *gracile* (Schwägr.) Loeske.

Very common.

One of the most frequent mosses, and met with from the lowlands up to mountain heights. It occurs, in numerous forms, both on dry and on damp rocks, and on more or less damp gravelly soil. On gravelly flats, especially above an altitude of about 300 metres, it often forms extensive growths. It occurs also very abundantly on tuff-rocks (for instance in Esja and below Eyjafjall) in a low, reddish-brown form. Fruit is always present.

77. *Schistidium apocarpum* Br. eur.

Subsp. *confertum* (Funck) Dixon.

E. Iceland: Hof!; Seydisfjörður!. N. Iceland: Husavik, at an altitude of about 400 metres!; Reykjahlid!; between Hnausar and Lækjarmot!; Vidvik (P. Söfóniasson)!, several places near Eyjafjörður (O. D.)!.

This form has its main distribution in N. Iceland, where it is rather common; thus, near Reykjahlid it was found abundantly on lava-blocks. It grows by preference on rather dry rock-faces, or upon stones, and has been gathered everywhere in fruit.

78. *Schistidium alpicola* (Sw.) Limpr.

Var. *rivularis* (Brid.) Wahlb.

Very common in E., N. and W. Iceland, more rare in S. Iceland, where it is absent from many localities.

This species grows on stones and rock surfaces in rivers, often in great abundance, covering the banks and the stones in the water for long distances. It does not appear to ascend much higher than about 300—400 metres above sea-level.

The chief reason for its occurring more scantily in South Iceland must be sought in the fact that the water in many rivers is turbid, owing to the glacier-clay carried in them. In this part of Iceland it is met with especially in rivers with clear water, at an altitude of 200—400 metres, more rarely in the low land.

Var. *eualpicola* Loeske. *Grimmia alpicola* Swartz.

N. Iceland: Dettifoss!, fr.

This form, which in the above locality grew on blocks of basalt at some distance from the waterfall, but nevertheless exposed to the spray, appears to be as rare in Iceland as in most of the rest of Europe. Forms, intermediate between this form and var. *rivularis*, have not been collected.

79. *Grimmia commutata* Hübener.*Grimmia ovalis* (Hedw.) Lindb.

N. Iceland: Mývatnsbraun (St.)!. W. Iceland: Budir (H. J.)!. In the supplement to "Isl. Kryptogamflora" (B. T., vol. 20, p. 105) Grønlund has recorded *G. ovata* from Mývatnsbraun and *G. commutata* from Vallanes and Kolfreyjustadr. But according to the specimens in the Botanical Museum in Copenhagen, determined by C. Jensen, the plant from Mývatn is *Grimmia commutata* and those from the two other localities are *G. ovata*. Grønlund has, therefore, probably confused the two names (*G. ovata* and *G. ovalis*) used by C. Jensen.

80. *Grimmia Doniana* Smith.

E. Iceland: Common from Hornafjörður to Seydisfjörður!. N. Iceland: Hólar (Gr.)!; Vidimýri (Gr.)!. NW. Iceland: Dýrafjörður!; Gnupsdalur!; Dýnjandi!. Common in SW. and S. Iceland.

With the exception of N. Iceland, where it appears to be rare, this species is widely distributed in the more low-lying districts of the country, as it is only by exception that it ascends higher than 200—300 metres. Near Holt in S. Iceland it has, however, been collected plentifully at about 500 metres above sea-level. It usually grows in small, round tufts on loose blocks, more rarely in wide cushions, irregular in form. In South Iceland proper — for instance near Drángshlíð — it occurs also on faces of tuff-rock. The fruit, which occurs everywhere, was hardly ripe even at the end of July.

81. *Grimmia alpestris* Nees.

E. Iceland: Arnkelsgerdi; Eidar (H. J.)!, sterile. S. Iceland: Hafursholt!, fr.

82. *Grimmia ovata* W. et M.*Grimmia ovalis* Lindb.

Iceland leg Mörch!. E. Iceland: Kolfreyjustadur (H. J.)!; Vallanes (H. J.)!; Seydisfjörður!; Berufjörður!. N. Iceland: Hnausar in Vatnsdalur!; Reykjaheidi!; Herjardalsheidi (Gr.)!. Only sterile specimens have been found.

This species grows on dry stones and rocks; it is rather frequent in East and North Iceland, but has not been found in the other parts of the country.

83. *Grimmia incurva* Schwgr.

E. Iceland: Vallanes!.

It was growing in the above locality on a slightly inclined, partly inundated rock-surface in the river Lágafliot.

84. *Grimmia patens* (Dicks.) Br. eur.*Dryptodon patens* Brid., Limpr.

E. Iceland: Hornafjörður!. W. Iceland: Budahraun (H. J.)!; Hafnarfjörður!.

In Budahraun it was growing in the clefts in the lava-field; near Hafnarfjörður it was found in abundance associated with *Orthotrichum rupestre* and *O. Sturmii* on the face of a dolerite rock with a northern exposure.

85. *Grimmia funalis* (Schwgr.) Sch.

Widely distributed over the whole of Iceland.

G. funalis is by far the most frequent species of this genus. It grows everywhere on dry rocks, especially on the vertical sides of ravines and lava-clefts, where it forms immense cushions, often 5–6 cm. deep, which very easily break up into pieces when loosened from the substratum. The fruit, which occurs rather frequently, was not ripe even in August. This species is most frequent up to about 300–400 metres above sea-level, but often ascends, however, to somewhat above 500 metres, for instance near Akureyri.

86. *Grimmia torquata* Hornsch.

E. Iceland: Hornafjörður!, very common; Seydisfjörður!. N. Iceland: near Hrutafjörður (H. J.)!. NW. Iceland: Dýnjandi!; Grunnavik!; Arngerðareyri!. W. Iceland: Melar (Gr.)!; Hafnarfjörður (Gr.)!; Budahraun (H. J.)!. Very common in SW. Iceland!.

This species is very common in SE., S. and SW. Iceland, rather rare in N. and NW. Iceland. It grows on dry rock-faces in ravines and lava-clefts, but only sterile specimens have been found.

Note. *Grimmia pulvinata* is enumerated in several older lists, but these records are probably due to a confusion with other species.

87. *Rhacomitrium sudeticum* (Funck) Br. eur.*Grimmia microcarpa* (Gmel.) Lindb.

Common over the whole of Iceland.

In many parts of Iceland *R. sudeticum* is one of the most frequent species, being found from the sea-level up to the gravelly flats of mountain heights. It is most widely distributed in NW. Iceland and along several fjords in E. Iceland, for instance Seydisfjörður, while it appears to occur less abundantly in N. Iceland. It grows on rather dry rocks and blocks of lava, in clefts, and on wet stones in and by streams. In mountain heights, especially in NW. Iceland, it forms the bulk of the vegetation on gravelly flats from about 300 metres upwards.

It varies considerably in size, habit, colour and length of hair point. On wet rocks it becomes very large, and almost black, with very short hair point, while the forms growing on dry rocks are as a rule very low in growth and slender, often occurring in small round, compact tufts, blackish green or brownish red in colour, with longer

hair point. In the birch coppices of NW. Iceland a form frequently occurs on larger, scattered stones which, in habit, reminds one of *R. fasciculare*. The tufts are flat towards the edge, dark-green; the hair point is very short and often wanting. The forms from mountain heights are often jet-black (var. *atrata*) or — on damp gravelly flats — yellowish green at the top, and grow in extensive, discontinuous mats, a few cm. thick. The fruit, which is very common, ripens in the beginning of June.

88. *Rhacomitrium heterostichum* (Hedw.) Brid.

E. Iceland: Hornafjörður!; Hof!; Geithellir!; Berufjörður!. N. Iceland: Akureyri!, at an altitude of 350 metres. NW. Iceland: Patreksfjörður!; Arngerðareyri!. Common in S. and W. Iceland!.

Common throughout E. Iceland, from Berufjörður, and southwards through the whole of S. and W. Iceland.

In W. Iceland it occurs abundantly at the head of Isafjörður, near Arngerðareyri, but has not been collected about the fjord further outwards towards its entrance; it was also common by Patreksfjörður. It appears to be more rare in N. Iceland.

The plant grows most frequently on dry rocks, and more rarely on those that are damp; it occurs in masses, for instance, in the lava districts of SW. Iceland. It is most common in the low land, but is, however, also met with at about 600 metres above sea-level. Fruit is rather common.

89. *Rhacomitrium microcarpum* Brid.

Grimmia ramulosa Lindb.

N. Iceland: Hof by Eyjafjörður (O. D.)!, sterile.

Recorded by Grönlund from Reykjavik and Husafell, but the specimens in the Botanical Museum in Copenhagen must be referred to *R. canescens*.

90. *Rhacomitrium canescens* (Weis) Brid.

Very common.

Next to *R. hypnoides* the most widely distributed species, and met with as frequently on mountain heights as in the low land, and in numerous forms. It grows both on rocks and on earth, especially where it is somewhat damp. In the "*Grimmia* heath" it often covers the more low-lying tracts with its light yellowish-green to greyish-green mats, while *R. hypnoides* grows in the more dry parts, but both species often occur mixed. It is also the most abundant constituent of the vegetation on damp sandy or gravelly soil by streams, in grass-fields with a poor soil, etc. Forms with the hair point entirely or almost wanting (*f. epilosa*) are frequent in wet localities.

Fruit is only rarely and scantily met with. Near Hof in E. Iceland plants were found in the middle of June with old capsules, and near Sugandafjörður about July 1st with yet green capsules.

91. **Racomitrium hypnoides** (L.) Lindb.

Grimmia hypnoides Lindb.; *Racomitrium lanuginosum* (Ehrh.) Brid.

Very common over the whole of Iceland.

Racomitrium hypnoides is by far the most common plant in Iceland. In all parts of the country, both along the coasts and on the mountain heights, it covers, almost without any mixture of other plants, vast tracts of land — the *Grimmia* heaths so well-known also from other Arctic countries — with its thick greyish-white mats. It also occurs in almost every locality where it is not too damp, and very often intermixed in tufts of other mosses. Thus, it is very common on rocks and stones, and often covers large tracts of lava-fields with cushions one foot deep. In bogs it grows, as a rule, on the top of the knolls, in company with species of *Hylocomium*, and in birch coppices it forms, in association with *Hylocomium* spp, *Hypnum uncinatum* and several other species, the moss carpet of the floor. Only sterile specimens have been found.

92. **Racomitrium fasciculare** (Schräd.) Brid.

Very common in the Southern, Western and Eastern parts of Iceland. In N. and NW. Iceland it appears to be somewhat less plentiful, but nevertheless it must also there be regarded as one of the more commonly occurring species.

It occurs at all altitudes up to the limit of vegetation on mountain heights. It forms, there, like *R. sudeticum*, black Alpine forms on dry rocks.

This species usually grows on stones and rocks in dry situations, but it also occurs frequently in gravelly soil. Occasionally it may even be found in the lowermost portion of birch-trunks. The fruit, which is rather common, ripens in the lowlands in the first half of June.

93. **Racomitrium aciculare** (L.) Brid.

Very common on wet rocks in and by rivers and waterfalls everywhere in the low-lying parts of the country. It does not appear to ascend much higher than 300–400 metres. The fruit, which occurs everywhere, ripens, as a rule, in the beginning of June.

Note. *Grimmia* (*Racomitrium*) *elliptica* is recorded in older lists as found in Iceland by Mörch. The specimens in the collections belong to *R. fasciculare*.

Cinclidotus fontinaloides, also, is recorded by Hornemann as found in Iceland, but it was undoubtedly confused with another species. Specimens are not to be found in the collections.

94. **Hedwigia albicans** (Web.) Lindb.

Hedwigia ciliata Ehrh.

SW. Iceland: Hafnarfjörður (Gr.)!, sterile.

FAM. ORTHOTRICHACEÆ.

95. **Amphidium lapponicum** (Hedw.) Schimp.*Anæctangium lapponicum* Hedw.

Very common.

This species usually grows on damp rocks, especially in clefts and crevices, but may also occur on a more dry substratum, for instance in lava caves and among stones on heaps of debris at foot of cliffs (Urd). It grows both on bare rocks and on humus in rock-clefts, occasionally also in gravelly soil or on earth, and even upon the sides of knolls in bogs. It does not appear to ascend to any great height on the mountains; it is most widely distributed up to 200—300 metres above sea-level, but it has, however, been found, although scantily, up to about 500 metres above sea-level.

The fruit was usually ripe in the first half of June.

96. **Amphidium Mougeotii** (Br. eur.) Schimp.*Anæctangium Mougeotii* Lindb.

Iceland (Mörch; Stp.)!. E. Iceland: Seydisfjörður!; Stóð (H. J.)!; Hof near Eyjafjörður (O. D.)!; Hrútafjörður (St. !); Myvatn (Gr.)!. NW. Iceland: Kaldalon!; Bæir!; Arngerdareyri!; Dýnjandi!. West, South-west and South Iceland: common!.

Common all over the southern and western part of the country and probably also in NW. Iceland, certainly everywhere north of Isafjörður. In N. Iceland it appears to be rarer, but occurs abundantly near Eyjafjörður. In E. Iceland it is common everywhere around Seydisfjörður and is probably also frequent elsewhere. It usually grows in large, thick cushions on damp rock-sides in clefts, and by waterfalls, but is also one of the species most commonly found in lava-caves.

This species rarely ascends to any great height on the mountains. In Esja it occurred 400 metres above sea-level, and has nowhere been collected at a greater altitude. Only sterile specimens have been found.

97. **Ulota phyllantha** Brid.*Ulota maritima* C. M. et Kindb.*Weissia maritima* Britt.

E. Iceland: Everywhere along the coast from Hornafjörður to Berufjörður!. NW. Iceland: Frequent around Isafjörður!. W. Iceland: Snæfellsnes (H. J.)!; Stykkisholmur!; common near Reykjavik, Hafnarfjörður and everywhere around Hvalfjörður!. S. Iceland: Vestmannaey!.

This species is probably common everywhere along the coasts, where it grows in company with *Grimmia maritima* quite close to the sea-side. It is only rarely met with at a distance from the sea, as, for instance, around Reykjavik, and in a few places in the lava-fields near Hafnarfjörður. The reason why it has not been collected in North

Iceland is probably due to the fact that the coast there has been but little investigated. At Husavik the coast cliffs consist of easily weathered tuff which is very poor in mosses, the surface being too much inclined to crumble away. *Grimmia maritima* occurred also very sparingly there, and *Ulota* was not found at all. Like *Grimmia maritima* it keeps chiefly to the shores of broad fjords; therefore it was not found, or was very rare, in the interior of the deep fjords of East and North-west Iceland, nor did these two species occur at Akureyri. On Vestmannaey *Ulota phyllantha* was the most commonly distributed moss; it occurred abundantly everywhere, reaching up the face of the cliffs and being also found on that side of the latter which faced the interior of the island. It often descended to the ground, it was thus found on the knolls in a wind-torn grass-field on the slopes of Helgafell associated with *Rhacomitrium hypnoides* and *Hylocomium* spp.

98. *Orthotrichum anomalum* Hedw.

S. Iceland: Vestmannaey!; Drángthlid (H. J.;!).

On Vestmannaey it was rather frequent on tuff-rocks at the foot of Stora Klit and in Heljusdal. The fruit was ripe in the first days of June. Near Drángthlid it was found on dry tuff-rocks, associated with *O. rupestre*, *Grimmia Doniana* and *Homalothecium*. The plants from this habitat form a transition to *O. saxatile*, as slender cilia, which easily fall off, are often found on them. The capsule is however 8-striate, and the diameter of the spores is 0,012—0,018 mm. as in *O. anomalum*.

99. *Orthotrichum saxatile* Schimp.

SE. Iceland: Hornafjörður!, on rocks in company with *O. Sturmii*. The fruit was ripe in the middle of June.

100. *Orthotrichum cupulatum* Hoffm.

S. Iceland: Vestmannaey!, fr.

It was growing in the above locality on fallen blocks of tuff at the foot of Stora Klit; in the first days of June it had capsules which had just ripened.

In older lists this species as well as *O. affine* and *O. lejocarpum* is recorded from Iceland as collected by Mörch; the habitats are not given more particularly, and no specimens of these species are to be found in the collections, so all the records are probably due to confusion with *O. Blyttii*.

101. *Orthotrichum rupestre* Schleich.

Common all over Iceland except in the north-west, where it has been observed only at the head of Isafjörður near Arngardareyri.

It grows on dry rocks and detached blocks in the lowlands, and probably does not ascend higher than about 400 metres above sea-level. The fruit ripens in the first half of July.

102. *Orthotrichum Sturmii* Hornsch.

E. Iceland: Hof!; Hornafjörður!. W. Iceland: Hafnarfjörður!; near Hvalfjörður!.

Growth similar to that of *O. rupestre*, and usually found in company with it. Near Hafnarfjörður it was found abundantly on the dry northern face of a dolerite-rock.

The plant from Hornafjörður forms in regard to the eight coarse cilia a transition to *O. rupestre*, but the upper half of the leaf consists of two layers of cells instead of only one in *O. rupestre*.

103. *Orthotrichum Killiasii* C. M.

E. Iceland: Seydisfjörður!. N. Iceland: Ásbyrgi!. W. Iceland: Dalasýsla, Melar on a cliff inhabited by sea-fowl (?) (H. J.)!.

The plant from Melar, which was quite sterile, was determined by C. Jensen, but owing to the absence of fruit the determination is doubtful.

Near Seydisfjörður, where it grew on rocks close to the sea shore, the fruit was ripe about the 1st of July.

104. *Orthotrichum Blyttii* Schimp.

Iceland (Stp.)!. E. Iceland: Djupivogur!; Seydisfjörður!. N. Iceland: Geitaskard!; Vidímýri (Grl.)!. NW. Iceland: Arngerdareyri!. W. Iceland: Stykkisholmur!; Esja (Grl.)!.

Grows on rocks, especially near the coast. Thus near Djupivogur Seydisfjörður, Arngerdareyri and Stykkisholmur it was found abundantly on the rocks of the coast. But it occurs also in the interior of the country; for instance, abundantly in several localities in Blönddalur and eastwards to Vidímýri.

Grönlund's specimens are determined by Lindberg as *Orthotrichum arcticum*, but on comparing numerous specimens of *O. arcticum* and *O. Blyttii* it has not been possible for me to find any real difference between these two forms. Hagen (*Musci Norvegiae Borealis*, p. 83) also regards *O. arcticum* as a variety of *O. Blyttii*, from which it is said to differ both by its shorter and broader leaves and by the shorter striæ of its capsule; but both these features vary so greatly in the Iceland plants, that there is hardly any basis for establishing variety, still less for separating them into two species. The perichaetial leaves are usually about 2—5 times as long as they are broad, with margins which are revolute from a short distance below the apex down to the base. The capsule is usually striated along its whole length, rarely (as in the plant from Stykkisholmur) in the upper half only. The peristome-teeth are finely papillose, rarely marked with faint sinuose lines in their lower half.

105. *Orthotrichum lævigatum* Zett.

N. Iceland: Grimsey (O. D.)!; Akureyri, 350 metres above sea-level!; Vidímýri!. NW. Iceland: Arngerdareyri!. W. Iceland: Kalmanstunga (Grl.)!.

Like *O. Blyttii* it grows on dry rocks and in many places in company with this. It has been everywhere collected in fruit.

FAM. ENCALYPTACEÆ.

106. *Encalypta ciliata* (Hedw.) Hoffm.

Leersia laciniata Hedw.

Iceland (Mörch)!. E. Iceland: Hornafjörður!; Djúpivogur!; Hof!; Berufjörður!. N. Iceland: Ljosavatn!; Tverá in Öxnadalur!. W. Iceland: Stykkisholmur!. Common in South and West Iceland (Gr!;!). Vestmannaey!.

This species has its widest distribution in the southern part of the country, where it is common from Berufjörður in East Iceland and thence southwards and westwards as far as Borgarfjörður. It has not been found in NW. Iceland and it is less frequent in North Iceland.

It grows sometimes in small colonies on humus-covered rocks, sometimes in rock-fissures filled with soil, usually associated with *Mnium orthorrhynchum*, *Anoetangium lapponicum*, *Bartramia ityphylla*, *Pohlia cruda*, *Distichium*, *Myurella* spp. etc. It has its main distribution in the lowlands. In Esja it ascends on exception to about 400 metres above sea-level.

In E. Iceland the fruit was quite unripe at the end of June; at Ljosavatn it had just ripened on July 19, but the calyptra still persisted. In S. Iceland, also, it ripens in the latter half of July.

107. *Encalypta rhabdocarpa* Schwgr.

Leersia rhabdocarpa Lindb.

Common in localities similar to those of the preceding species; it often occurs abundantly also on the peat-walls of houses and on walls. It is met with both near the coast and in the interior of the country — for instance, abundantly at Reykjahlid — and is frequent as far upwards as almost 500 metres above sea-level.

The fruit ripens, as a rule, at the end of June, but both overripe and just ripe capsules may frequently be found in the same tuft much later in the year.

Var. *pilifera* (Funck) Br. germ. frequently occurs in company with the type.

108. *Encalypta contorta* (Wulf.) Lindb.

Leersia contorta Lindb.

W. Iceland: Budahraun, on lava (H. J.)!, sterile.

Note. *Encalypta vulgaris* is recorded by Zoëga and Mörch, and *E. commutata* by Lindsay, but no specimens of either species occur in the collections. *Georgia pellucida* is recorded by Zoëga and Vahl as found in Iceland, but of this species, also, no specimens are found in the collections, and all the above records are no doubt due to erroneous determinations.

FAM. SPLACHNACEÆ.

109. *Dissodon splachnoides* (Thunb.) Grev.*Tayloria lingulata* (Dicks.) Lindb.

Iceland (Mörch)!. E. Iceland: Seydisfjörður. N. Iceland: Common everywhere!. NW. Iceland: Sugandafjörður!; Isafjörður!; Ármuli!; Arngerdareyri!. W. Iceland: Brattabrekka!. S. Iceland: Barkarstaðr!. 550 metres above sea-level.

Grows on damp boggy ground, almost always mixed with other mosses such as *Hypnaceæ*, *Cinclidium*, *Meesia trichoides*, *Dichodontium* and *Bryum ventricosum*. In N. Iceland, where it is most widely distributed, it extends from the lowlands to a height of upwards of 600 metres above sea-level. Thus, near Husavík, it was very common in *Hypnum* bogs, and near Akureyri it was found especially in bogs at an altitude of 500–600 metres. Near Seydisfjörður it was common from about 100 metres upwards to the mountain heights. From the south-western and southern part of the country it appears to be absent, or is at any rate very rare; it was found in this part of the country only in a *Hypnum* bog near Barkarstaðr, at an altitude of 530 metres.

110. *Tetraplodon bryoides* (Zöëga) Lindb.*Tetraplodon mnioides* (L. fil.) Br. eur.

E. Iceland: Djupivogur!; Berufjörður!. N. Iceland: Akureyri (Carrington); Mývatn (Gr.)!; Reykir near Svinavatn (Gr.)!; Flateyarsdalsheidi (St.)!; near Eyjafjörður (O. D.)!. NW. Iceland: Dynjandi!. W. Iceland: Husafell (Gr.)!; Brunnar (Gr.)!; Reynivellir (Gr.)!; Kolvidarhol!; Hafnarfjörður!. S. Iceland: Draupahlid (Wiinsted)!.

Occurs here and there all over the country, but as a rule only in single tufts on the bodies of dead animals. Near Djupivogur a large tuft was found on a rotten fish.

The fruit, which occurs abundantly everywhere, ripens at the end of June.

111. *Splachnum sphæricum* (L. fil.) Swartz.*Splachnum pedunculatum* (Huds.) Lindb.

Iceland (Mörch)!. commonly distributed!.

Grows on cow-dung in wet, marshy ground, often mixed with *S. vasculosum*, but is less frequent than the latter. It occurs most frequently in North Iceland and also, to a certain extent, in East Iceland (Seydisfjörður and Vallanes), where it is met with abundantly in many localities, it is somewhat rarer in South and South-west Iceland and probably does not ascend higher than 300–400 metres above sea-level.

The fruit ripens rather irregularly, so that in the same tuft both ripe and also quite young capsules may be found. The majority of the

fruits ripen during July; near Seydisfjörður many were found to be ripe on July 1st, and in South Iceland ripe capsules were collected between 10—15 June.

Splachnum tenue is recorded by Gliemann to have been collected by Mörch, but the specimens in the herbarium collected by Mörch belong partly to *Splachnum sphæricum* and partly to *S. vasculosum*.

112. *Splachnum vasculosum* L.

Commonly distributed.

Like the preceding species it grows, often abundantly, on cow-dung in wet marshy ground. It is most frequent in the lowlands, but ascends also as far upwards as to the mountain heights. Thus at Seydisfjardarheidi it was common up to about 600 metres above sea-level, and in NW. Iceland also it was found as far upwards as about 500 metres. Such forms from mountain heights are as a rule low in growth and have short setæ.

As is the case with *Splachnum sphæricum* the fruit ripens at different times during the course of the summer, from the first half of June into August.

Splachnum ampullaceum, as recorded to have been found by Koenig, is undoubtedly nothing else but *S. vasculosum*.

FUNARIACEÆ.

113. *Funaria hygrometrica* L.

Commonly distributed all over the country.

It usually grows on peaty ground, associated with *Dicranella crispera*, *Polytrichum gracile*, *P. juniperinum*, *Bryum* spp., etc., but is also found on humus-covered rocks and on tuff. It does not occur abundantly, as a rule, and it does not ascend to any great height, doubtless not higher than to an altitude of 300—400 metres. The fruit ripens in the beginning of August. The spores vary considerably in size in this species, from 0.011 to 0.021 mm., in plants which otherwise show no deviation from the type.

114. *Entosthodon ericetorum* (Bals. et De Not.) Br. eur.

Funaria obtusa (Dicks.) Lindb.

W. Iceland: Kleppjarnsreykir in Reykholtdalur!; Englandshver! In both places with ripe fruit (25—30 July).

This species grew in the above localities on warm ground. Near Englandshver it grew along the outlet of a spring. Near Kleppjarnsreykir it was found both on a stone standing in water of a temperature of about 50°, mixed with *Blindia acuta*, *Aneura multifida*, *Anthoceros* and *Scapania irrigua*, and also on warm, damp ground mixed with *Fissidens osmundoides*.

Note. *Entosthodon fascicularis* is said to have been found by Hornemann near Reykjavik, but no specimens of it can be found in the collections, and the occurrence of this species in Iceland is not probable.

FAM. BRYACEÆ.

115. *Leptobryum pyriforme* (L.) Schimp.

Very common in the majority of the districts of Iceland. This species, especially in N. and NE. Iceland, is common on peat or damp ground, but also on rocks, especially in soil-filled fissures. In S. Iceland it occurs abundantly on damp rock-sides, in the clefts of tuff rocks, and by rivers. It is only in NW. Iceland that it appears to be rarer. There it is common along the sea-side around Nauteyri and Arngerdareyri, but is otherwise rare in this part of the country and has only been found close to the coast.

The fruit ripens late in summer. In N. Iceland only some of the fruits were ripe at the end of July. In specimens collected near Eyjafjörður by O. Davidsson in Sept.—Oct. the capsules were ripe, but the lids were not yet thrown off.

116. *Anomobryum filiforme* (Dicks., Lindb.) Husnot.

E. Iceland: Hornafjörður!; Berufjörður!; Stafafell!. W. Iceland: Patreksfjörður!, at an altitude of about 150 metres; Botnsdalur!; Esja, Möðruvellir!, at an altitude of about 200 metres; Alafoss!. S. Iceland: Fljótshlíð, common!; Eyjafjall, common!.

Rather common in E. Iceland as far as Berufjörður, and in W. Iceland; common in S. Iceland; not found in the northern part of the country. It grows, as a rule, scantily on damp rocks, mixed with other mosses, such as *Blindia acuta*, *Anæctangium compactum*, *Amphidium lapponicum*, *Aneura pinguis*, etc., occasionally, however, also in large, pure cushions. In S. Iceland it occurred everywhere on the faces of damp tuff rocks, mixed with other mosses. Fruit was found only near Holt in S. Iceland.

117. *Anomobryum concinnum* (Spr.) Lindb.

S. Iceland: Hrutafell!.

It was growing here rather scantily on the face of a damp tuff rock, mixed with *Blindia acuta*, *Metzgeria furcata*, *Barbula rubella*, *B. cylindrica* and *Myurella julacea*.

118. *Plagiobryum Zierii* (Dicks.) Lindb.

E. Iceland: Stafafell!; Berufjörður!. N. Iceland: Mývatn (Gr!.)!. NW. Iceland: Arngerdareyri!; Patreksfjörður!. W. Iceland: Nordredalur by Borgarfjörður!; Esja, in several places!; Lundur!; Bardshellir (Gr!.)!;

Hafnarfjörður (Grí.); Geitháls!. S. Iceland: Skálholt!; Thingvellir!; Breidabolstadr!; Vestmannaey!.

Frequent in the western and south-western parts of the country from Borgarfjörður southwards, rarer in the other parts. It chiefly occurs in humus-filled rock-fissures and in lava caves, but also upon damp rocks by waterfalls, in small reddish tufts, or mixed with other mosses such as *Plagiothecium pulchellum*, *Mnium orthorrhynchum*, *Pohlia cruda*, *Myurella apiculata*, *M. julacea*, *Blepharostoma trichophyllum*, etc. It does not appear to ascend higher than about 300 metres above sea-level. Fruit has been found only in Almannagjá and very scarcely; ♀ plants are rather common.

119. *Plagiobryum demissum* (H. et H.) Lindb.

W. Iceland: Möðruvellir in Esja!.

It was growing here in company with *Anomobryum filiforme* on a stony slope at an altitude of about 200 metres. The fruit was ripe on July 17th, but the lids had not yet been thrown off.

120. *Pohlia acuminata* Hornsch.

W. Iceland: Geitabergsvatn!. S. Iceland: Seljaland!, 250 metres above sea-level; Thingvallahraun near Tintron!; Almannagjá!.

This species grows on dry stony ground in birch coppices or on rock-ledges. Thus on Thingvallahraun it grew on small slopes in the birch coppice in company with *Pohlia nutans* and *Heterocladium squarrosulum*. Near Geitabergsvatn, also, it grew on the ground in the coppice in unmixed tufts, 5–10 mm. high, with setæ, 10–15 mm. long. On July 20th the capsules were ripe, dark brown, with lids low and conical, muticous.

121. *Pohlia polymorpha* H. et H.

W. Iceland: Möðruvellir in Esja!.

It was growing in the above locality on a tuff-slope at an altitude of about 400 metres.

122. *Pohlia cruda* (L.) Lindb.

Very common.

This is one of the most commonly occurring mosses, and is of almost equal frequency at all altitudes. It usually grows in rock-clefts filled with soil and on soil-covered ledges, but is also met with both on rather dry and on damp ground, as for instance on knolls in bogs.

The fruit, which is very frequent, ripens in the first half of August.

123. *Pohlia nutans* (L.) Lindb.

E. Iceland: Seydisfjörður!; Vallanes!. N. Iceland: Mývatn (Gr!.)!; Hálsskogur!; Heljardalsheidi (Gr!.)!. NW. Iceland: Dýrafjörður!; Isafjörður!; Sugandafjörður!; Jökulsfjörður!. W. Iceland: Breidabolstadr!; Reykjavik (Gr!.)!. S. Iceland: Frequent near Thingvellir (Gr!.)!; Draupahlid (Wiinsted)!.

P. nutans was first found in Iceland by Steenstrup, who did not, however, give the habitat. It is also recorded by Mörch, but all the specimens collected by him have been wrongly determined. It usually grows on a rather dry substratum. In the majority of the localities it occurred on the ground in birch coppices, as for instance in NW. Iceland, where it is common everywhere in the coppices at the head of the fjords. In that part of the country it also grows both frequently and abundantly on peat, and has been collected up to a height of about 350 metres above sea-level.

In the other parts of the country it is rather rare, and was as a rule found in small quantities only. Only around Thingvellir was it rather common in the birch coppices. In NW. Iceland the fruit was ripe about July 1st.

124. *Pohlia cucullata* (Schwägr.) Bruch.

Iceland (Mörch)!; Holtevad heath (Gr!.)! (determined by Zetterstedt as *Webera Ludwigii*). N. Iceland: Akureyri, at an altitude of about 800 metres. NW. Iceland: Isafjörður!, at an altitude of about 350 metres: Dýnjandi!; Arngerdareyri!.

Near Akureyri it was growing in gravelly soil saturated with melting snow, associated with *Polytrichum sexangulare*, *Dicranum Starckeii*, *Pleuroclada albescens*, etc. The fruit was almost ripe on July 23rd. In NW. Iceland it was common in several places north of Isafjörður on damp ground (peat) at the bottom of the valley. Here the fruit was not quite ripe in the beginning of July.

125. *Pohlia Ludwigii* (Sprengel) Schimp.

Pohlia Weigelii (Schimp.) Lindb.

N. Iceland: Ljosavatnsberg!.

In the above locality it grew abundantly on damp gravelly soil at an altitude of about 500 metres. Only sterile specimens were found.

126. *Pohlia commutata* (Schimp.) Lindb.

Very common.

Pohlia commutata is one of the most frequent species, especially in the Alpine region; at elevations from about 300 to 600 metres it is met

with everywhere on damp ground, often forming the bulk of the vegetation, for instance in several places in NW. Iceland. It is, however, also common in the more low-lying districts, where it grows especially on damp soil along streams.

Pohlia commutata is a most variable species, and occurs in Iceland in numerous forms. The tufts are, as a rule, loose, and as much as 6 cm. high. In more particularly sheltered localities, for instance in lava-clefts near Thingvellir, the plants are very vigorous, and form deep, not-coherent tufts which are hardly tomentose. But in damp depressions on the mountain heights they often form extensive, deep and dense cushions which are brownish grey in the interior and yellowish green only at the top; compact forms like this occurred abundantly on damp gravelly flats, 400—500 metres above Isafjörður. The single plants are slender, with a thin fragile stem, and with leaves appressed, shortly pointed, slightly toothed towards the apex and longly decurrent. The leaf-cells are shorter, sometimes thin-walled, sometimes rather highly thickened and porous, but both the form of the leaves and of the cells, and the thickness of the walls may vary considerably in the same tuft or even on the same plant.

The fruit, which occurs rather frequently, was usually ripe at the end of July.

127. *Pohlia gracilis* (Schleich.) Lindb.

Very common.

In the lowlands this species grows, as a rule, on damp ground along streams, either in unmixed tufts or, more often, associated with *Alicularia scalaris*, *Lophozia quinquedentata*, *Cephalozia bicuspidata*, *Pohlia commutata*, etc. On cold, wet gravelly ground it is sometimes the most abundant constituent of the vegetation; thus it was growing in enormous quantity below the "Jökull" in Kaldalon (NW. Iceland). In the Alpine region from about 300—700 metres, *Pohlia gracilis* is one of the most frequently occurring species, and grows everywhere on damp gravelly flats, chiefly scattered among other mosses such as *Anthelia Juratzkana*, *Alicularia* spp., *Polytrichum sexangulare* and *Oligotrichum hercynicum*, more rarely in larger, unmixed growths.

The fruit, which occurs very frequently, ripens on the mountain heights usually at the end of July, in the lowlands a month earlier (Kaldalon, June 22).

128. *Pohlia Rothii* (Correns) Broth.

Pohlia annotina (L.) Lindb.

N. Iceland: Husavik ♂!; Stadr near Hrutafjörður!

It was growing in both places on damp sandy soil, associated with *Dicranella crispa*, *Aongstromia longipes* and *Hepaticæ*. The gemmæ, which occurred only few in number, were quite typical.

Webera annotina Hedw. is recorded from the peninsulas of NW. Iceland (Stp.) and from Hafnarfjörður (Gr.), but as the collections con-

tain no specimens from these localities it cannot be decided which species is meant.

129. **Pohlia tenuifolia** (Schimp.).

Webera bulbifera Warnst.

E. Iceland: Hamarfjörður!; Berufjörður!; Seydisfjörður!. N. Iceland: Geitaskard!; Hnausar!. W. Iceland: Reykjavík! ♂.

P. tenuifolia is the most frequent of the small gemmiferous species of *Pohlia*. It usually grows on damp sandy soil, and often very abundantly, always bearing the characteristic gemmæ. Near Geitaskard it covered in company with species of *Bryum* the bottom of a dried up lake.

The leaves in all the Iceland plants are very longly decurrent.

130. **Pohlia grandiflora** H. Lindberg.

S. Iceland: Reykir!; Laugarvatn! ♂; Barkarstadr!; Midskálagil near Holt!; cave near Steinafjall!.

Near Reykir it was growing on the ground along a stream, associated with *Dicranella crista*, *Pogonatum urnigerum*, *Scapania curta* and *Lophocolea minor*. Near Laugarvatn it was found abundantly on a warm clayey flat, associated with *Aongstroemia longipes*, *Gymnocolea inflata* and a small sterile *Philonotis*. ♂ flowers were very numerous, but gemmæ were absent. In the other places it was found on faces of tuff rocks, associated with *Bartramia ityphylla*, *Pohlia cruda*, *Didymodon rubellus* and *Distichium montanum*. The gemmæ were quite typical in all these species.

Pohlia tenuifolia is an excellent species, easily known, even when gemmæ are absent, by the strong sheen and the narrow, longly decurrent leaves, in the upper half of which the cells are very narrow and often wavy.

131. **Pohlia prolifera** Lindb.

N. Iceland: Vidimýri!.

It grew here rather scantily on damp sandy ground along a stream, bearing typical gemmæ.

132. **Mniobryum albicans** (Wahlb.) Limpr.

Pohlia albicans Lindb.

Very common.

Var. *glacialis* (Schleich.) Limpr.

Very common.

Both the type and the variety are the most common mosses everywhere on damp ground. The type grows on the ground along streams,

in bogs and on damp rocks. Var. *glacialis* grows always in cold water, especially in moss bogs, where in company with *Philonotis* it usually forms the bulk of the vegetation. In the Alpine region *Pohlia albicans* occurs abundantly, even at a height of about 600 metres. There it grows especially in and along watercourses, often filling up their — during summer — dried up beds by growing in large cushions both on the ground and on stones. As in *P. commutata*, the Alpine forms become more compact, with shorter, concave, appressed leaves and looser cell-tissue. Such forms have been found, for instance, near Dýrafjörður at an altitude of 300–400 metres, Esja at an altitude of about 500–600 metres and near Seljaland at an altitude of about 500 metres. Fruit occurs rather rarely, and in the type, as a rule, in a small quantity only. Fruiting specimens of the type were collected near Akureyri (ripe July 22), Holt (ripe July 19) and Breiddal (hardly ripe June 19). Var. *glacialis* was collected in fruit near Eyjafjörður (O. D.) and near Kaldalon in NW. Iceland, where the plant grew abundantly on inundated ground along small streams, and was often covered with fruit which was not quite ripe at the end of June.

133. *Bryum purpurascens* (R. Br.) Br. eur.

E. Iceland: Seydisfjörður!, common; Vallanes! (H. J.). N. Iceland: Mývatn (Grl.)!; Akureyri!, common; Husavik!, common. NW. Iceland: common about Isafjörður and Jökulsfjörður!. W. Iceland: Reykholtdalur (Grl.)!; Nordredalur!; Grimstunga (Grl.)!; Bardshellir (Grl.)!. S. Iceland: Traustholtsholm in the Thjorsá (F.)!.

Grows on damp peaty or sandy soil, especially near the coast. It occurs abundantly chiefly in places where the peat has been pared off. Near Seydisfjörður it was collected up to a height of about 400 metres. The fruit ripens in the beginning of August.

Bryum purpurascens varies rather considerably in the form of the capsule and in the structure of the peristome. The capsule is usually symmetrical, sometimes slightly asymmetrical, and then reminds one of *B. uliginosum*, from which it is, however, easily distinguishable by the large lid. The base of the peristome teeth (fundus) is often large and reddish yellow, and in the majority of the plants which have been investigated the lamellæ are sinuose in the middle, sometimes as strongly so as in *Bryum lapponicum*. The dorsal transverse segments are more or less distinctly transversely striated. The spores vary somewhat in size, from 0.024–0.035 mm.

It is a peculiarity with this species that the capsule, on being cut through and warmed in diluted ammoniacal water, imparts to the latter a substance which is intensely, but temporarily coloured red by the oxygen in the air. The same is often the case also with *B. uliginosum*. In the course of time the old capsules turn almost black in colour.

134. *Bryum lacustre* Blandow.

E. Iceland: Berufjörður!; Vallanes (H. J.)!. N. Iceland: Common near Husavik!; common near Eyjafjörður (O. D.)!; Saudanes (St.)!; Svinadalur!;

NW. Iceland: Bildudalur (C. H.)!. W. Iceland: Lundur!. S. Iceland: Traust-holtsholm in the Thjorsá (F.)!; Breidabolstadr!.

Rather common, especially in N. and E. Iceland. It grows on damp sandy or peaty soil, especially in places where the peat has been pared off, and by the sides of ditches. Near Husavik it was growing plentifully on damp slopes stretching down towards the sea, in association with *Leptobryum*, *Aongstrœmia*, *Bryum inclinatum*, etc. Near Lundur it was growing in company with *Dichodontium*, *Aongstrœmia*, *Dicranella Schreberi* and *Bryum inclinatum* on peaty flats which had been pared off. The fruit was ripe near Berufjörður on June 20th, near Breidabolstadr on July 16th.

135. *Bryum Kaurini* Philib.

E. Iceland: Berufjörður (Grl.)!.

The specimens, which are quite typical, were gathered with ripe fruit on July 6th, 1878, and determined by Berggren as *B. inclinatum*.

136. *Bryum archangelicum* Br. eur.

NW. Iceland: Hesteyri!. W. Iceland: Esja (Grl.)!; Brjanslækur (H. J.)!. S. Iceland: Drángshlid (H. J.)!.

Both rare and scanty on rather dry, sandy ground or on soil-covered rocks. The fruit ripens at the end of July.

137. *Bryum Jörgensenii* Kaurin.

SW. Iceland: Thingvellir!.

The Iceland plant agrees exactly with *B. archangelicum* in habit. The leaves are narrowly and indistinctly bordered; the perichætal leaves have their margins revolute to the apex. The plants are often purely ♀; usually, however, a few antheridia and many archegonia are present. In none of the plants investigated did the lamellæ show the slightest sinuosity. The spores, which were yellow and almost smooth, were of very much the same size as in *B. archangelicum*.

138. *Bryum inclinatum* (Sw.) Br. eur.

Very common everywhere on a more or less damp substratum, on peat, sand and gravel, on soil-covered rocks, and in rock-clefts. It does not appear to ascend higher than about 300—400 metres above sea-level.

Bryum inclinatum varies so considerably in all its parts, in habit and size, in the length of the setæ, in the form and degree of inclination of the capsule, in the structure of the peristome, the size of the spores and in the form and cell-tissue of the leaf, that it is hardly possible to collect two tufts which do not show diversities in one respect or another. Perhaps on a closer investigation many of the forms might possibly be referred to some of the numerous "small species" established by

Hagen, Bryhn, Ryan, Arnell, Limpricht and other authors, or might with as great justice be described as new species. But without comparison with original specimens, and only according to the descriptions, it is impossible to form any opinion of the value of these species, which have very often been collected only in small quantity, and from a single locality, and which will therefore in many cases prove to be maintainable only so long as there does not exist more than the one specimen. It is very probable that it will not even be possible to maintain as varieties a great many of these forms which have been given specific rank, the characters used for separating the species being so variable that, on having abundant material for investigation, it is impossible to draw any boundary line between the forms. Here, only thorough investigations made at the habitat will be able to throw some light on the influence of the external conditions on the specific characters.

The height of the tufts and the length of the stems vary according to the degree of dampness, so that plants from dry and exposed habitats are low in growth with close-set leaves, and from damp localities, as a rule, higher, with elongated stems and more distant leaves. Also in places, slightly illuminated, for instance among grass and *Carex*-tufts, do the plants become higher with elongated stems. The leaves in *Bryum inclinatum*, in contradistinction to those in several other species of the same group, are stated to be not decurrent. This feature appears, however, to vary considerably, and to be closely connected with the habit of the plant, forms with short stems having close-set, not decurrent leaves, while the leaves on elongated stems are, as a rule, more or less decurrent. In such forms the uppermost close-set leaves have almost always a rounded, not decurrent base, while the leaves further down on the stem become more strongly decurrent the further they occur apart from one another. The form of the cells of the basal angles of the leaf also vary greatly according to the position of the leaf on the stem. The not decurrent leaves have a rounded base with quadrate, somewhat widened and thin-walled cells, but as the leaves downwards become more and more decurrent, the cell-form becomes elongate rectangular. The leaf-form varies from narrow-lanceolate to almost ovate, with a shorter or longer point. The lower leaves are usually shorter and broader, and the nerve vanishes just below the apex. The leaf-margin is revolute to the apex, more rarely it is plane in the upper part. The form of the leaf-cells is partly dependent on the leaf-form, long, narrow leaves having elongated cells, while broad, short leaves have broader cells, and even in leaves of the same plant the cell-form may vary considerably. The cell-walls vary somewhat in thickness. Xerophilous forms have often thick cell-walls, while bog-forms with large, broad leaves have thin-walled cells. The capsule varies in form from obovate to elongate-ovate. The neck of the capsule is usually straight, more rarely slightly curved.

The peristome teeth vary in colour from pale yellow to brownish yellow, being very strongly coloured where inserted. The "insertion" may be very differently developed, all transitions are met with, from a slightly indicated yellowish-brown or orange ring at the base of the peristome teeth to a highly developed compact thickening (fundus)

which may be almost as large as, for instance, that in *B. retusum*. It is, however, not usual for the thickening to be distinctly localized around the base of each individual peristome tooth; it has more the character of a continuous ring, 0.02–0.07 mm. broad. Hagen (Musci Norv. Borealis, p. 141) pronounces the opinion that ultimately all the species with a distinct fundus will be united together in a separate group in a natural system of species of *Bryum* (*Brya hæmotostomata*). The feature in question appears, however, to be too variable for that purpose. It is especially in the group of forms of *inclinatum* that this peculiar development of the peristome base occurs, but it is also met with in other groups, although less frequently, for instance in *B. purpurascens* where it may be almost as large as in *Brya hæmotostomata* Hagen) and in *B. uliginosum*. *B. curvatum* Kaur. & Arnell, which Hagen refers to *B. hæmotostomata*, also belongs to the *purpurascens pallens* group. On the other hand, forms may also be met with in which the fundus is rather slightly developed or even quite wanting, for instance *B. Kaurini*, *B. retusum* and *B. Graefianum*, referred by Hagen to *B. hæmotostomata*. This diminishes the value of the character in question, and it does not appear to have greater systematic importance than has the peculiar structure of the lamellæ for the group *Hemisynapsium*, which structure is especially met with in the group of species in which the fundus formation occurs. Both the fundus formation and the indentation of the lamellæ, as also the occurrence of perforations in the median line of the peristome teeth, are probably connected with certain external influences, and are very often met with together. Here it is especially the degree of salinity of the substratum which is of importance, aulacodonte peristomes being found almost exclusively in *Bryum* forms collected from localities close to the coast, while forms with a distinct fundus-formation, although most frequent in the vicinity of the sea, yet have also been found far inland, or at a height of 400–500 metres above sea-level. In Iceland indented lamellæ and peristome teeth more or less perforated in the median line have been observed in forms of *B. inclinatum*, *B. retusum*, *B. archangelicum*, *B. calophyllum* and *B. purpurascens*, in the last-mentioned species, however, the peristome teeth are never perforated.

The spores vary somewhat in size, most frequently 0.022–0.025 mm., more rarely as much as 0.029 mm.

Bryum lapponicum Kaurin has not been found in Iceland, but forms which approach this species by having broader and longly decurrent leaves are rather frequent.

139. *Bryum retusum* Hagen.

N. Iceland: Hnauðar in Vatnsdalur!; Vidimýri!; W. Iceland: Stykkisholmur!; Borgarnes!.

This species grows on peat or soil-covered rocks. The capsules ripen in the beginning of July. Near Stykkisholmur they were almost ripe on June 15th. In all the plants referred to this species the leaves were shorter and broader than in *B. inclinatum*, with the nerve vanishing in the apex and shortly excurrent in the perichætal leaves. The capsule

is narrower than in *Bryum inclinatum*, not-glossy, dark brown, finely pitted (in *B. inclinatum* smooth and glossy), with a high and conical lid. The peristome teeth are narrow, dark yellow, with a very large, red fundus which is very easily loosened from the mouth of the capsule and falls off together with the peristome tooth belonging to it, equally wide to the middle or gradually tapering from the base, and very differently formed in the same peristome. Lamellæ 12–18 in number, very differently developed even in the same peristome, straight or sinuous,

frequently also porous in the median line of the teeth. The spores vary somewhat in size, from 0.020 mm. (Borgarnes) to 0.024–30 mm. (Vidmýri).

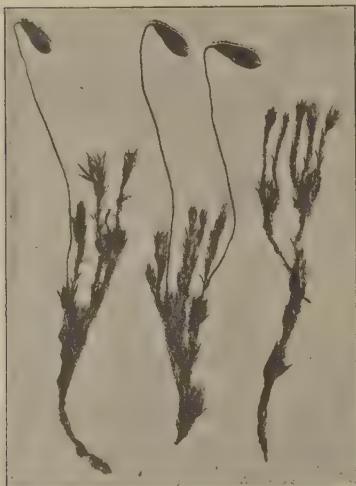


Fig. 2. *Bryum islandicum* (× 2).

140. *Bryum islandicum* n. sp.

Cæspites densi ad 5–6 mm. alti.

Caulis ruber, fragilis, valde tomentosus, innovationibus brevibus, numerosis.

Folia caulina inferiora decur rentia, 1.5 mm. longa et 0.7–0.9 mm. lata, superiora non vel vix decur rentia, ovata, longius cuspidata, apicem versus parce denticulata, 2–2.2 mm. longa et 0.75 mm. lata, ad basin rubra; margine tota longitudine reflexa, seriebus 3–4 cellularum angustiorum limbata. Cellulæ leptodermes paulum porosæ, basilares rectangulæ, 0.03–0.04 mm. longæ et 0.02 mm. latæ, ceteræ elongato hexa-

gonæ, 0.03–0.04 mm. longæ et 0.015–0.018 mm. latæ. Costa ad insertionem rubra, in aristam longam excurrentis.

Folia perichætialia intima anguste lanceolata, vix limbata, costa excurrente longiuscule cuspidata.

Inflorescentia synoica; antheridia et archegonia numerosa.

Seta ad 15–20 mm. longa et 0.16 mm. crassa, rubra.

Capsula pendula, deoperculata ca. 3 mm. longa et 1 mm. crassa, opaca fusca leptodermis, sicca leviter rugulosa. Operculum humile conicum. Annulus latus. Cellulæ exothecii leptodermes, marginales in series 3–4 transverse rectangulæ-polygonæ quadratæ, ceteræ irregulares.

Exostomii dentes e fundo fusco-aurantio 0.4 mm. longi et 0.065 mm. lati, fusco-aurantii apice lutei, anguste limbati, subtiliter punctulati. Lamellæ 14–16, inter se liberæ, marginibus integris. Endostomium exostomio haud connatum, luteolum, parce papillosum; processibus lanceolatis, in carina ovaliter fenestratis, ciliis pro more rudimentariis.

Sporæ 0.039–0.038 mm. diam. olivaceæ, punctulatæ.

N. Iceland: Akureyri, on damp ground at an altitude of about 300 metres, July 20th, 1909.

141. *Bryum calophyllum* R. Brown.

E. Iceland: Vallanes!, on wet boggy ground. The capsules were quite green even on June 27th.

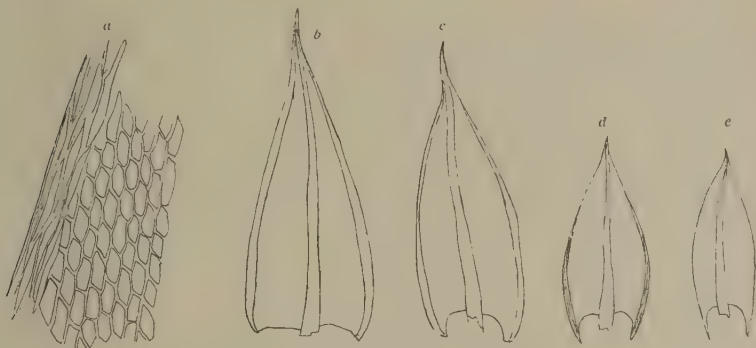


Fig. 3. *Bryum islandicum*. a, Leaf margin ($\times 120$); b and c, perichaetial leaves; d and e, leaves.

142. *Bryum uliginosum* (Bruch) Br. eur.

N. Iceland: Husavik!; Svinadalur!. W. Iceland: Haukadalsheidi!, at an altitude of about 300 metres.

In all the above localities it grew abundantly on damp, sandy ground.

On Haukadalsheidi the fruit was ripe on Aug. 1st, in the other localities it was unripe in the middle of July.

Besides ♂ and ♀ flowers, a few hermaphrodite flowers also occur frequently. The papillæ of the peristome are in the lowermost transverse segments often distinctly arranged in transverse rows, and sometimes there are also distinct transverse bars as in *B. purpurascens*. As is the case in the latter species, the ripe capsule contains a colouring matter which on being treated with ammonia assumes a red colour in the air.



Fig. 4. *Bryum islandicum*. Peristome ($\times 120$; phot.).

143. *Bryum Grœnlundii* n. sp.

Cæspites laxiusculi, ca. 1.2 cm. alti, superne virides, subnitentes; surculi innovationes tenues.

Folia caulina decurrentia, inferiora ovata, breviter cuspidata, superiora longius cuspidata, breviter vel non decurrentia, 2.3 mm. longa et 0.9–1 mm. lata, apice integra vel leviter dentata; margine ad apicem reflexa, seriebus 2–4 cellularum angustiorum limbata. Cellulæ foliaries leptodermes, indistincte porosæ, basilares rectangulæ, 0.035–0.050 mm. longæ et 0.018–0.020 mm. latæ, ad insertionem rubræ; illæ folii medii



Fig. 5. *Bryum Groenlundii* ($\times 3$).

elongato-hexagonæ, vel rhomboideæ 0.05–0.08 mm. longæ et 0.015–0.018 mm. latæ, apicales angustiores. Costa fusco-lutea, ad insertionem 0.08 mm. lata, in foliis inferioribus sub apice desinens, in superioribus in cuspidem integram excurrens.

Folia perichætialia intima anguste triangula, margine limbata.

Inflorescentia synoica; antheridia perpauca; archegonia et paraphyses numerosæ, rosæ.

Seta 3–4 cm. longa et 0.20 mm. crassa, rubra.

Capsula nutans, arcuato-clavata deoperculata 3.35 mm. longa et 1 mm. crassa, sub orificio obliquo rubra contracta; collum 1.5 mm. longa. Operculum humile conicum, apice rubro. Annulus 0.14 mm. latus, triplex. Exostomii dentes e fundo purpureo vel rubro-aurantio bene definito 0.40–0.45 mm. longi et 0.10 mm. lati, fusco-lutei, anguste limbati, dense et subtiliter papillulosi; lamellæ ca. 24, inter se liberæ, margine integra. Endostomium exostomia vix adhærens, luteum, subtiliter papillulosum; processus dentibus æquilongi, fenestrati; Cilia nulla. Sporæ olivaceæ, 0.025–0.033 mm. diametro, punctulatæ.

W. Iceland: Haukadalsheidi on damp gravelly ground at an altitude of about 350 metres, August 1st, 1909.

144. *Bryum fallax* Milde.

N. Iceland: Geitaskard!, fr.

It was growing here in a dried up pool among *Pohlia tenuifolia*.

145. *Bryum æneum* Blytt.

Bryum rutilans Brid.

E. Iceland: Djupivogur!; Seydisfjörður!; at an altitude of 400 metres. N. Iceland: Akureyri!, at an altitude of 350 metres. NW. Iceland: Bildu-

dalur (C. Hansen)!. NW. Iceland: Lundur!, fr. S. Iceland: Vestmannaey!; fr.; Skálholt!; Austerhlið near Geysir!; Breidabolstadr!; Barkarstadr!; Holt!, fr.; Drángshlíð!.

Common in the southern part of the country and on Vestmannaey; rarer in the other parts of the country. In S. Iceland it grew especially

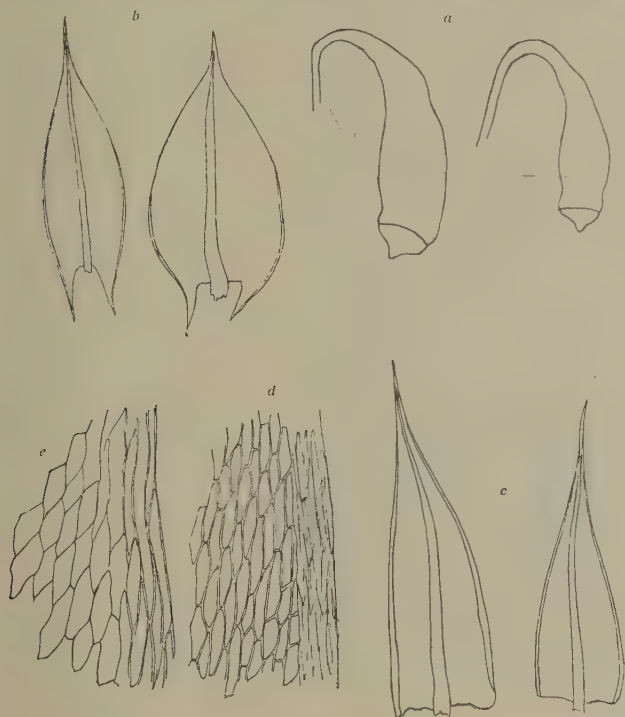


Fig. 8. *Bryum Greenlundii*. a, Capsules ($\times 20$); b, leaves ($\times 20$); c, perichaetial leaves ($\times 20$); d, leaf margin at base, and e, from the middle of the leaf ($\times 120$).

abundantly everywhere in clefts of tuff rocks, and on Vestmannaey it was also frequent on the faces of damp tuff rocks. It was found in several localities in fruit, which was quite green even in the beginning of July. Near Lundur it was found on damp ground, associated with other *Bryum* spp. and *Dichodontium*, and had ripe fruit at the end of July. In several of the fruiting specimens from this locality a few hermaphrodite flowers were found besides the numerous ♀ flowers. ♀ plants occur everywhere, but ♂ plants have not been found.

In the leaf-angles of all the plants investigated hair-formations were found, consisting of readily falling, 8–10 celled, brown, papillose hairs, which very easily break into pieces of 2–4 cells. The leaves vary from shortly pointed, with nerve vanishing just below the apex, and shortly

rhomboid, equilateral-hexagonal or almost quadrate cells (forms from Akureyri), to more or less longly pointed, with excurrent nerve, and narrower, rhomboid or elongate-hexagonal cells.



Fig. 7. *Bryum Groenlundii*. Peristome ($\times 250$; phot.).

146. *Bryum bimum* Schreb.

E. Iceland: Vallanes.

It has been collected only scantily on damp ground, with capsules which were not ripe at the end of June.

Two sterile *Brya*, collected by Helgi Jónsson near Stöd in E. Iceland and in Budahraun, are referred to this species by C. Jensen. The leaves in both the plants taper to a long point, are longly decurrent, have narrow basal cells, and the nerve excurrent; therefore, the plants probably belong to *Bryum affine*, but owing to the absence of fruit the determination is quite uncertain.

147. *Bryum affine* (Bruch) Lindb.

Bryum cuspidatum Schimp.

Commonly distributed.

One of the most frequent species of *Bryum*, and occurs everywhere in the lowlands on damp sandy or peaty ground, and on humus-covered rocks. The fruit ripens in the first half of July. It varies exceedingly in all its parts. It is said to differ from the very nearly allied *B. cirratum* in its sex, the smaller, smooth spores, and the decurrent leaves with the broader cells; but all these features are so variable that in reality it is hardly possible, at least in the Arctic countries, to separate these two species.

The plant is usually synoicous, but ♂ flowers are also almost always present; ♀ flowers are more rare. The spores vary in size from 0.008 to 0.020 mm., and often differ rather considerably in size in the same capsule, or in different capsules from the same tuft; the most frequent size is 0.012–0.017 mm.; they are sometimes smooth, sometimes finely papillose. The leaves vary in form from about ovate to lanceolate, tapering more or less to a long point, and with the nerve longly excurrent. In form the leaf-cells correspond nearly with the leaf, so that short leaves have broader cells than have those which are long and narrow.

The leaf-base, at any rate in the lower leaves, is decurrent, with elongated, narrow alar cells. The close-set uppermost leaves are usually not decurrent, and then have the base rounded, with quadrate, somewhat widened alar cells.

The structure of the leaf-base evidently depends on the degree of dampness of the habitat. *Bryum cuspidatum* usually grows on boggy ground and forms here tufts, 1—3 cm. high, with rather long innovations. On such elongated shoots the leaves are always decurrent. On a more dry and exposed substratum, for instance on rocks, the tufts become lower in growth and denser, and then the leaves are only slightly, or not at all, decurrent, and in connection with this the alar cells are short as in *Bryum cirratum*.

148. *Bryum cirratum* Hoppe et Hornsch.

Rather common.

Grows in drier localities than does *B. affine*, for instance in gravelly soil, on slopes and among grass. It is especially common in NW. Iceland, and occurred abundantly for instance on stony slopes near Dýrafjörður.

The forms which are here referred to *B. cirratum* have ♂, ♀ and numerous ♂ flowers. The leaves are not decurrent, taper to a very long point, with narrow, almost linear cells in the upper portion. The spores are 0.014—0.020 mm., yellow, and finely papillose. *Bryum affine* and *B. cirratum* form a continuous series of forms, in which *B. affine* represents the hygrophilous and *B. cirratum* the xerophilous adaptation-form.

149. *Bryum intermedium* (Ludw.) Brid.

N. Iceland: Grimsey (O. D.)!; Vidimýri!; Stadr near Hrutafjörður!.
S. Iceland: Merkjáfoss (F.)!.

Rather rare and scanty on damp soil. Near Stadr the fruit was ripe on August 1st, but the lid still persisted.

150. *Bryum pallescens* Schleich.

Widely distributed.

One of the most frequent species everywhere up to a height of about 300 metres above sea-level. It usually grows on damp rocks, where it often forms very large and deep cushions, with numerous capsules; but it also occurs on damp soil. In South Iceland it is very common everywhere on faces of tuff rocks. The plant is, as a rule, monoicous, but very often hermaphrodite flowers are also met with, containing many antheridia and a few archegonia.

151. *Bryum subrotundum* Brid.

S. Iceland: Uxavatn (F.)!.

152. *Bryum capillare* L.

E. Iceland: Hamarfjörður!. N. Iceland: Mödrufellshraun (St.)!; Grimsey (O. D.)!. W. Iceland: Hvammur (Gr.)!; Hafnarfjörður!; Videy!, several places near Reykjavík!. S. Iceland: Breidabolstadr!; Holt!. Vestmannaey!.

This species occurs, as a rule only sparingly, on humus-covered rocks and in lava-clefts. Only on Vestmannaey was it common, occurring especially on the tumbled-down blocks at the foot of cliffs inhabited by sea-fowl.

The nerve usually vanishes just below the hair-shaped leaf-point. In the plant from Mödrufellshraun and in the majority of the specimens from Vestmannaey the nerve varied considerably in length, sometimes reaching scarcely beyond the middle of the leaf, sometimes almost to the apex. The plants from the former habitat, in addition, bore clusters of easily falling brown threads in the uppermost leaf-angles, quite similar in appearance to those in *Bryum cœneum*.

153. *Bryum caespitium* L.

Iceland (Krabbe, 1863)!. E. Iceland: Seydisfjörður!; Vallanes (H. J.)!; Hallormstádaskogur!. N. Iceland: Hálsskogur!; Stáartunga (O. D.)!; Víðvík (P. Sofóniasson)!. S. Iceland: Almannagjá!.

Grönlund records this species from Reykjavík and Laugardalur, but there are no specimens of it from these localities in the collections.

Grows in dry sandy soil, especially in birch coppices, and appears to be rather frequent in North and East Iceland. It occurred abundantly in several localities in Hálsskogur. Near Vallanes it occurred sometimes on dry sandy soil, sometimes on the dikes and peat-walls of the farm. In Hálsskogur the fruit was ripe on July 19th, but some of the lids still persisted.

154. *Bryum comense* Schimp.

N. Iceland: Reistarárgil (O. D.)! ♀; Hof (St.)!.

Both the above localities are situated on the east side of Eyjafjörður.

155. *Bryum elegans* N. v. Es.

E. Iceland: Djúpivogur! ♂; Berufjörður (Gr.)!. N. Iceland: Reykjahlid! ♂. NW. Iceland: Isafjardarheidi, at an altitude of 450 metres! ♂ and ♀. W. Iceland: Hafnarfjörður!; Svinahraun!. Vestmannaey!.

Not common, but sometimes abundant in humus-filled rock and lava clefts, etc. Near Reykjahlid it was common in the lava-field.

Varies considerably in leaf-form, the length of the nerve, etc. The plant from Isafjörður has distinctly bordered, erect spreading, and narrower leaves, and belongs most nearly to var. *carinthiaca* (Br. eur.) Breidl. In lava-clefts there usually occurs a low, compact form with

concave, adpressed, and not bordered leaves, with loose cell-tissue and not excurrent nerve, which agrees most closely with var. *Fercheltii* (Funck) Breidl.

156. *Bryum argenteum* L.

Commonly distributed.

This species has been found only in the lowlands, where it is especially frequent around inhabited localities. It grows there on the peat walls of the houses, on the dikes and on the ground in the neighbourhood of the dwelling houses, and prefers, on the whole, a well-manured substratum. It is also common near the sea-side, both on sandy soil and upon stones, and occurs especially abundantly below cliffs inhabited by sea-fowl, for instance on Vestmannaey.

157. *Bryum Neodamense* Itzigs.

Var. *ovata* (Jur.) Lindb. et Arnell.

E. Iceland: Seydisfjörður!, sterile.

It was growing here in cushions about 6 cm. high, in water in a stream, at an altitude of about 100 metres.

158. *Bryum Duvalii* Voit.

Very common.

Grows everywhere on very wet ground or in water, especially in moss bogs or along the banks of streams, where it often forms large vinous red cushions in the light green patches of *Philonotis*, *Bryum ventricosum* and *Mniobryum albicans*. As a rule it does not ascend higher than 300—400 metres. Near Barkarstadr in S. Iceland it was found at an altitude of 500 metres. The fruit, which ripens in the middle of July, is rare, and has been found only rather scantily near Berufjörður, Ljosavatn and Tverá in Öxnadalur.

159. *Bryum pallens* Sw.

Widely distributed.

Grows on a damp substratum, both on soil and on rocks. In S. Iceland it is very common on faces of damp tuff rocks. It grows especially on the marginal strip of soil and on the slopes along streams, in small reddish tufts, associated with *Dichodontium*, *Philonotis* and *Dicranella crispa*, but it is very often sterile. On the promontory near Reykjavík it grew in enormous quantities on damp peaty ground, with masses of capsules which, in the first week of August, were ripe, but the lids were not yet thrown off.

It is only by exception that *Bryum pallens* ascends higher than about 300 metres above sea-level. Near Berufjörður it has been collected at an altitude of about 500 metres.

Note. *Bryum turbinatum* is recorded from Iceland by Mörch, Hornemann and Grönlund, but all the specimens in the collections are wrongly determined.

160. *Bryum ventricosum* Dicks.

Very common.

One of the most frequent mosses, which occurs in numerous forms everywhere on a damp substratum, both on soil and on rocks. In water, for instance in moss bogs and along the banks of streams, it forms extensive, light green mats. The plants are only slightly tomentose, with large, spreading leaves, and thin-walled cells. In bogs, where it occurs everywhere in abundance, it is sometimes low in growth, sometimes as much as 6–7 cm. high, and often richly fruiting. Forms from a more dry substratum, for instance from rocky clefts, are low in growth and densely tomentose. It is common upwards of 600 metres above sea-level.

161. *Bryum arcticum* (R. Br.) Br. eur.

This species is widely distributed over the whole of Iceland, but occurs, as a rule, rather sparingly.

It grows on peat, on damp sandy soil and on humus-covered rocks, usually mixed with other *Brya*, and hardly ascends higher than 200–300 metres. The fruit ripens at the end of July.

It varies rather considerably. The capsule is sometimes short and inflated, sometimes more slender. The spores vary from 0.020–0.035 mm. The lamellæ are usually connected by one or two transverse bars. Near Seydisfjörður a form has been collected with a partly aulacodont peristome and very few transverse bars.

162. *Bryum pendulum* (Hornsch.) Schimp.

N. Iceland: Hof (O. D.)!. W. Iceland: Reykjavík!; Reykholtalur!. S. Iceland: Gilfoss (F.)!; Barkarstadr!; Breidabolstadr!. Vestmannaey! In previous lists some more habitats have been enumerated for this species (Grl.; H. J.), but they are all due to confusion with other species, mostly with *B. arcticum*.

Bryum pendulum appears to be rather rare and, as a rule, has been found only in small quantity mixed with other *Bryum* spp. on damp sandy soil or on damp tuff rocks. Fruit ripens in the beginning of August.

As in *Bryum inclinatum* the base of the peristome may be rather differently developed. Thus, in a specimen from Breidabolstadr, a rather large reddish-yellow thickening had been developed which could be loosened from the mouth of the peristome together with the peristome tooth belonging to it, as in the species of Hagen's *Brya hæmatostoma*.

One of the specimens from Hof, collected by O. Davidson, was monoicous, but was otherwise quite typical.

163. *Bryum Brownii* Br. eur.

N. Iceland: Hof (O. D.)!. W. Iceland: Reykjavík!.

On the peninsula near Reykjavík it occurred abundantly on damp sandy ground in company with *Bryum pallens* and *B. inclinatum*. Fruit was ripe on August 5th.

It is also recorded from several localities which are enumerated in Grönlund's lists, but all the corresponding specimens in the collections are wrongly determined.

164. *Mnium hornum* L.

Astrophyllum hornum Lindb.

E. Iceland: Common from Hornafjörður to Berufjörður!; Seydisfjörður!; Vallanes (H. J.)!. N. Iceland: Akureyri!; Hof near Eyjafjörður (O. D.)!; Geitaskard!; Vatnsdalur!. NW. Iceland: Common everywhere about Isafjörður!; Bildudalur (C. H.)!; Dyrafjörður!; near Jökulsfjörður!. W. Iceland: common everywhere (Gr.; H. J.;!). S. Iceland: Common! Vestmannaey!.

Common in East, South, West and North-west Iceland, rarer northwards. It occurred abundantly even in Vatnsdal and Blónddal (Geitaskard), but further eastwards it was collected only in a few localities near Eyjafjörður. It appears to be quite absent, for instance, from the district around Husavík. It grows almost exclusively on somewhat damp, peaty ground, especially on knolls or along the sides of ditches, more rarely on soil-covered rocks. ♀ plants occur rather frequently; on the other hand, it has not been found in fruit.

165. *Mnium orthorrhynchum* Brid.

Astrophyllum orthorrhynchum Lindb.

Very common everywhere in soil-filled rock-clefts, and ravines, on faces of damp tuff rocks, etc., and occurs in wide-spread unmixed tufts or more often mixed with other mosses. ♂ flowers are rather common; on the other hand, it has not been collected in fruit. It does not appear to ascend higher than 400–500 metres above sea-level.

166. *Mnium serratum* Schrad.

Astrophyllum marginatum (Dicks.) Lindb.

N. Iceland: Hof near Eyjafjörður (O. D.)!. Vidvík (P. Sofóniasson)!. W. Iceland: Giljáfoss and Kleppjarnsreykir in Reykholtisdalur (Gr.)!; Kalmanstunga (Gr.)!; Fell near Kollafjörður (St.)!; Alafoss!. S. Iceland: Flokastadagill!; Barkarstadr!; Holt!; Austarhlid near Geysir!. Vestmannaey!.

It grows on damp, shady rock-sides in caves and clefts in the lowlands, and is rather common in the southern part of the country.

where it often occurs abundantly in the clefts of tuff rocks. In West Iceland it is met with here and there, while it is rare in North Iceland and has not yet been found in East Iceland. The fruit, which is found everywhere, ripens in the first half of June.

167. **Mnium spinosum** (Voit) Schwægr.

Astrophyllum spinosum Lindb.

N. Iceland: Ásbýrgi (St.)!; Hof near Eyjafjörður (O. D.)!; Akureyri!

In all the above localities it was found on dry grass-covered ground growing among *Hylocomium proliferum*, *H. squarrosus*, *H. triquetrum*, *Hypnum uncinatum* and *Lophozia lycopodioides*. Near Akureyri it occurred, however, also on a somewhat damp slope (200 metres above sea-level), intermixed in a large tuft of *Mnium stellare*. Only ♀ flowers have been found.

168. **Mnium undulatum** (L.) Weiss.

Astrophyllum undulatum Lindb.

W. Iceland: Kollafjörður!, at an altitude of 100 metres. S. Iceland: Vik; Hnappavellir; Hjörleifshöfði (H. J.)!; Reykir!; Breidabolstadr!; Barkarstadr!; Seljaland!; Holt!; Drángshlid!. Vestmannaey!

This species has been found only in the south-western part of the country, where it is common on Flótshlid and along Eyjafjall. It was found in several places on Vestmannaey, for instance abundantly in Heljusdalur. It grows as a rule in damp soil at the foot of rock-walls and in clefts, especially in localities which are well protected and have a luxuriant grass-vegetation. It is also met with in damp caves, for instance near Reykir. Only sterile specimens have been found.

169. **Mnium cuspidatum** (L.) Leyss.

Astrophyllum silvaticum Lindb.

N. Iceland: Hof near Eyjafjörður (O. D.)!. S. Iceland: Holt!. Vestmannaey!.

Near Holt it grew at the bottom of and up on the sides of a small tuff-cave. On Vestmannaey it was found rather abundantly among grass on a somewhat damp slope.

Mnium cuspidatum is enumerated in Vahl's list, and has, moreover, been recorded from several localities by Grönlund, Stefansson and Helgi Jónsson. All these specimens are, however, wrongly determined, and the majority of them belong to *M. affine*.

170. **Mnium medium** Br. eur.

Astrophyllum medium Lindb.

SE. Iceland: Hornafjörður.

It grew here on boggy ground mixed with *M. affine* and *M. cinclidioides*.

171. **Mnium affine** Blandow.*Astrophyllum cuspidatum* (L.) Lindb.

Very common.

This species grows both in bogs, where it occurs everywhere and almost always intermixed with other bog mosses, especially *Hypnaceæ*, *Cinclidium stygium* and *Mnium cinclidioides*, and on the ground among grass, as also on rocks. It is most frequent in the lowlands, and hardly ascends higher than 400—500 metres above sea-level. ♀ plants are very common; on the other hand it has not been collected in fruit.

It varies considerably in habit, leaf-tissue and serrature of the leaf-margin. In very wet localities the annual shoots become erect and the stems often highly tomentose (var. *elata* Lindb.). On a more dry substratum, especially on humus-covered rocks, the annual shoots are bent downwards in a curve, and are rooting at the apex, and the fertile shoots are quite short. The leaves are only very slightly or not at all decurrent. In the forms from a dry substratum the leaf-cells are rather thick-walled, distinctly porous, and often collenchymatous; in bog-forms they are more thin-walled and slightly porous. The teeth of the leaf-margin are usually unicellular and obtuse, more rarely 2—4-cellular; forms are very frequently met with in which the teeth are very slightly developed or almost quite wanting, so that all transitions to var. *integrifolia* Lindb. occur. The latter form is occasionally met with, especially on rocks.

172. **Mnium Seligeri** Jur.*Astrophyllum Seligeri* (Jur.) Lindb.

E. Iceland: Hornafjörður!; Berufjörður!; Seydisfjörður!; Vallanes (H. J.)!. N. Iceland: Husavík!; Akureyri!; Ljosavatn!; Helgavatnsfloi (St.)!. W. Iceland: Stykkisholmur!. Very common in SW. Iceland!.

Grows on a very wet substratum, in marshes, moss bogs and along streams, and often very abundantly. ♀ plants are almost always met with; on the other hand, ♂ plants or plants in fruit have not been collected.

M. Seligeri is one of the mosses of most common occurrence in the south-western part of the country, from Hvalfjörður southwards, and also about Hornafjörður; it often forms the bulk of the vegetation, for instance in the great bogs in Ölfus. In E. Iceland it is rather common, and is also hardly rare in N. Iceland, but from NW. Iceland it appears to be quite absent. It is easily distinguished from *M. affine* by its broadly decurrent leaves, which are concave on the under surface. The leaf-cells are, as a rule, somewhat smaller than in *M. affine*, 0.04—0.07 mm., more thick-walled than in the latter species and decidedly collenchymatous; forms are, however, often found with thin-walled and somewhat larger cells, which are then hardly to be distinguished from *Mnium affine* v. *elatum* except by the decurrent leaves.

173. **Mnium stellare** Reich.*Astrophyllum stellare* Lindb.

E. Iceland: Berufjörður!; Hof!. N. Iceland: Akureyri!, fr.; Tverá in Öxnadalur!. W. Iceland: Waterfall in Brynjudalur (Gr!.)!. S. Iceland: Holt!; Vestmannaey!.

This species grows on damp soil, in rock-clefts, and on tuff, and as a rule sparingly. Near Akureyri it was found mixed with *M. spinosum* on a damp slope, and in fruit which was ripe on July 20th, but the capsules had not then thrown off their lids. Near Berufjörður it grew in the fissures in the basalt, mixed with *Pohlia cruda*, *Distichium montanum* and *Plagiothecium pulchellum*. In Heljusedalur on Vestmannaey it covered the vertical faces of large, tumbled-down blocks of tuff rock in company with *M. serratum* and *M. orthorrhynchum*.

174. **Mnium cinclidioides** (Blytt) Hübén.*Astrophyllum cinclidioides* (Blytt) Lindb.

Very common over the whole of Iceland.

The most common species of *Mnium*. It is hardly absent from any bog, where it often forms the bulk of the vegetation, and it is also found everywhere in moss bogs and along the banks of streams. It is common even at a height of above 400 metres above sea-level, and occurs, for instance near Seydisfjörður and Akureyri, in bogs at an altitude of about 500 metres. ♀ plants are common, ♂ plants and fruit have not been found in Iceland.

175. **Mnium punctatum** (L.) Hedw.*Astrophyllum punctatum* (L.) Lindb.

Very common all over Iceland.

Grows everywhere in damp localities, in marshes, where it often forms the bulk of the vegetation, in moss bogs, along the banks of streams, on wet rocks, by waterfalls, etc. It is most frequent in the lowlands up to 300—400 metres, but very often it ascends considerably higher, for instance in Svinaskard to about 500 metres above sea-level, and in Berufjardarskard to about 550 metres.

♀ plants are common: the fruit, which is frequently found, was overripe in the middle of June, and the capsules had thrown off their lids (E. Iceland).

176. **Mnium subglobosum** Br. eur.*Astrophyllum pseudopunctatum* (B. S.) Lindb.

E. Iceland: Hornafjörður!, sterile. N. Iceland: Hof near Eyjafjörður (O. D.)!, fr.; Stadr near Hrutafjörður!, fr.; Mödruvellir (St.); Mývatn (Gr!.)!, sterile. W. Iceland: Reykjavík!. The other habitats recorded by Grönlund belong to *Cinclidium stygium*.

This species is no doubt rather widely distributed, but often overlooked on account of its great resemblance to the far more frequently occurring *M. punctatum*. Like the latter it grows on wet boggy ground. Fruit was unripe both near Hornafjörður (June 11th) and near Stadr (July 29th).

177. *Cinclidium stygium* Sw.

Very common.

In East and North Iceland this species is one of the mosses of most common occurrence, and is found everywhere in bogs, where it is often the most abundant constituent of the vegetation. Here it grows by preference in the wettest parts, growing even in the shallow water on inundated ground or along streams, but it occurs also on more dry ground, and then usually mixed with other bog mosses, for instance, *Hypna*, *Mnia* and *Sphagna*. In the other parts of the country it is also common, although there it does not occur so abundantly; in South Iceland I have only observed it growing intermixed — as a rule scantily — with other bog mosses in, I think, every bog, but never in large growths. Near Akureyri it is frequent as far upwards as about 600 metres above sea-level, and in East Iceland, for instance near Berufjörður, it was collected up to a height of 550 metres. The fruit, which is common especially in North Iceland, ripens at the end of July.

Note. A small sterile plant, collected by Helgi Jónsson near Höfði, was by C. Jensen referred with doubt to *Cinclidium subrotundum*, but a closer investigation has proved that it must be referred to *C. stygium*.

FAM. MEESEACEÆ.

178. *Paludella squarrosa* (L.) Brid.

This species has a similar distribution to that of *Cinclidium stygium*. It grows in bogs and is exceedingly common especially in N. Iceland, where it sometimes occurs mixed with other bog mosses, sometimes in large, pure cushions. It is also common in E. Iceland, at any rate from Berufjörður northwards, in NW. Iceland and in W. Iceland. In S. Iceland it is far more rare, and has not been found, for instance, on Fljótshlid or below Eyjafjall. It does not appear to ascend very much higher than about 400 metres above sea-level. Fruit was found only near Eyjafjörður.

179. *Amblyodon dealbatus* (Dicks.) P. Beauv.

N. Iceland: Hof near Eyjafjörður (O. D.)!, fr.

It was growing here scantily, intermixed in a tuft of *Distichium montanum*, *Ditrichum flexicaule*, *Myurella julacea*, etc.

180. *Meesea trichoides* (L.) Spruce.

Meesea uliginosa Hedw.

Very common.

This species grows especially on boggy ground, but is also frequent

on wet sandy or gravelly ground and on damp rocks. In the greater part of the country it is very common in such localities; only in NW. Iceland and partly in S. Iceland does it occur more scantily, for instance on Fljótshlíð and below Eyjafjall. It is most frequent in the low land, but nevertheless often ascends up to a height of 500—600 metres above sea-level. The fruit, which is always present plentifully, ripens at the end of July.

181. *Meesea triquetra* (L.) Ångstr.

Meesea tristicha Br. eur.

Common in E. and N. Iceland!. NW. Iceland, Arngerdareyri!; W. Iceland: frequent about Reykjavík and Esja!; rarer and most scanty in S. Iceland.

It grows on boggy ground, sometimes in small unmixed tufts, sometimes intermixed with other mosses such as *Hypnaceæ*, *Paludella*, *Mnium affine*, etc. Only sterile specimens have been found.

182. *Catoscopium nigratum* (Hedw.) Brid.

Very common in E., N. and W. Iceland, more rare and rather scanty in NW. and S. Iceland. It grows on wet boggy ground, where it sometimes forms very dense tufts about 8—10 cm. high, sometimes grows interspersed in tufts of other mosses. It occasionally occurs so abundantly, especially in N. Iceland, that it may form the main part of the vegetation in the bogs.

Grönlund records that this species is one of the character-plants of the warm ground, and C. Jensen (Bot. Tid. XIV 1885) has described a var. *Grönlundii*: "filiformis, humilis, superne flavescens, inferne nigrescens. Folia subremota imbricata, minima, ovata lanceolata, integra vel subintegra, costa crassa in apicem evanida, cellulis minoribus, incrassatis et papillois," which was collected by Grönlund near a hot spring in Reykholtalur. In Grönlund's collections in the Botanical Museum in Copenhagen there are some mosses determined as *Catoscopium nigratum* or *C. nigratum* var. *Grönlundii* from a warm substratum. Of these only one specimen from Reykholtalur belongs to var. *Grönlundii*, and I have collected similar forms rather scantily near other hot springs. This form differs only slightly from the type, chiefly only in being less tomentose and in having shorter leaves. Almost all the other specimens of *Catoscopium* collected by Grönlund were wrongly determined, as they belong to *Archidium phascoides*, and on the whole *Catoscopium* occurs only accidentally and scantily on a warm substratum.

The fruit, which occurs very frequently and plentifully, was in June-July either old and emptied from the previous year or yet quite unripe.

183. *Conostomum boreale* Swartz.

Conostomum tetragonum (Vill.) Lindb.

Widely distributed over the whole of Iceland.

In W. and S. Iceland this species is found only by exception at a

lower level than about 250 metres, and not until a height of about 400 metres and upwards is it common. In N. and E. Iceland it is also most frequent in the Alpine region, but grows, however, abundantly down to the low land in many places, for instance near Hof in the south-east. In NW. Iceland it is very common from the sea-level up to the snow-line.

It usually grows on dry and stony — more rarely damp — ground, most frequently on rocky flats, where it forms exceedingly dense and compact cushions, as much as 10 cm. deep, which occur wedged very firmly into the substratum. The cushions are, as a rule, interwoven with hepatics such as *Lophozia alpestris*, *L. ventricosa* v. *porphyroleuca*, *Pleuroclada albescens*, *Cephalozia pleniceps*, etc.

Like many other Alpine species *Conostomum* also occurs in the lava-fields, for instance abundantly in the clefts near Thingvalla; the tufts are here considerably looser and less tomentose than in the Alpine form. Fruit, which occurs everywhere, ripens in the first half of August.

FAM. AULACOMNIACEÆ.

184. *Aulacomnium palustre* (L.) Schwägr.

Sphærocephalus palustris (L.) Lindb.

Very common on damp boggy ground along the banks of streams, and on damp, soil-covered rocks. It occurs most abundantly on knolls in bogs, in company with species of *Sphagnum*, and among *Carices* in damp tracts of meadow land. Only sterile specimens have been found.

185. *Aulacomnium turgidum* (Wahlb.) Schwägr.

Sphærocephalus turgidus (Wahlb.) Lindb.

E. Iceland: Hof!; Seydisfjörður!; Skreiddal!; Berufjardarskard!, at an altitude of 540 metres; Djupivogur!. N. Iceland: Vatnsdalsfjall (St.)!; Lækjarmot!, at an altitude of 350—450 metres; Akureyri!, at an altitude of about 900 metres. NW. Iceland: Grunnavik!, at an altitude of 260 metres; Armuli!, at an altitude of 150 metres. W. Iceland: Esja!, at an altitude of 420 metres. S. Iceland: Holt near Eyjafjall!; in several places from the low land up to 400 metres above sea-level.

This species is rather common especially in E. Iceland, in fact it may almost be called common there; for instance, near Hof in SE. Iceland it was very frequent and, in several localities, plentiful. It appears to be of almost equal frequency in the lowlands and on the mountain heights.

It grows especially on somewhat damp gravelly ground, more rarely on soil-covered rocks, associated with *Hylocomium*, *Rhacomitrium canescens*, *Dicranum congestum*, *Hypnum uncinatum*, etc. Near Hof it grew in great abundance along the river, on the gravelly flats covered with *Grimmia canescens*. Near Lækjarmot it was common as an intermixture in the *Rhacomitrium hypnoides* heath on the mountain slopes, about 350—400 metres above sea-level, and near Grunnavik it grew on damp rocks among other mosses. Only sterile specimens have been found.

FAM. BARTRAMIACEÆ.

186. *Bartramia ityphylla* (Haller) Brid.

Very common.

One of the most frequent mosses, both on a dry and on a somewhat damp substratum, from the lowlands to far up in the Alpine region. It grows in soil-filled rock-clefts, on dikes and house-walls, on peat and on the top of knolls in bogs. As a rule, it grows in small, unmixed tufts, but occasionally also mixed with other mosses. The fruit, which ripens during August, occurs plentifully everywhere.

187. *Plagiopus Cederi* (Gunn.) Limpr.

Bartramia Cederi (Gunn.) Sw.

E. Iceland: Berufjörður!, fr. N. Iceland: Hóf near Eyjafjörður (O. D.)!; Reistarárgil (O. D.)!, fr.

Near Berufjörður it grew abundantly on a wet rock-face with a northern exposure, in cushions, about 3 cm. high, with numerous capsules which were ripe at the end of June.

188. *Philonotis fontana* (L.) Brid.

Very common over the whole of Iceland.

One of the most frequent and abundantly occurring species which grows everywhere on a wet substratum, in marshes and moss bogs, along streams, and on wet rocks, but is also common on a more dry substratum, for instance in grass fields or on humus-covered rocks. It is of almost equal frequency at all elevations upwards to the limit of vegetation. The fruit, which is found very frequently, ripens in the low land about August 1st.

Philonotis fontana is extremely variable, and conditions pertaining to dampness especially exercise great influence over the appearance of the plant. The usual bog forms are highly tomentose, with erect or more or less falcato-second leaves (f. *falcata* Warnst.). On a more dry substratum the tufts usually become denser and more highly tomentose, and the plants more slender.

In the cold water in moss bogs and on inundated ground along rivers where the temperature during summer is often only 4°–6° this species, in association with *Pohlia albicans* var. *glacialis*, *Brachythecium rivulare* and species of *Mnium*, often forms the main part of the vegetation. Here it forms very high and loose, in fact hardly cohering, tufts, which often resemble *P. seriata* in habit. The stems are flaccid and hardly tomentose; the leaves are short and appressed or slightly second, and often obtuse or cucullate at apex. The nerve is very broad and widened at the base. Such cold-water forms agree exactly with Loeske's *P. fontana-adpressa* (L. Loeske, Kritische Bemerkungen über einige Formen von *Philonotis*, Hedwigia, vol. 45, p. 100, and Kritische Übersicht der eur. *Philonoten*, Hedwigia, vol. 45, p. 195). That it is the cold water which checks the growth of the radicles and causes the

characteristic form of the leaves and the looser cell-tissue is seen from the fact that, in situations where the water-level is altered, forms may be found growing in tufts, in the lower part of which the stems are tomentose and the leaves normal, while all the young shoots which have developed after the habitat has been inundated have the typical *depressa* appearance. Likewise are found all possible transitions between *P. fontana* and the *depressa* form.

On mountain heights, where the snow lies long, the slopes are often covered with *f. nigrescens* Loeske, with black, prostrate and hardly to-



Fig. 8. *Philonotis fontana* (L.) Brid. Slender form from warm ground (Thorlákshver; nat. size).

mentose stems and light yellowish-green annual shoots. This form has beyond doubt originated from the pressure of the snow-covering. The leaves are, as a rule, shortly pointed. Where the water from the melted snow remains and soaks the tufts the leaves become still more shortly pointed and the cell-tissue looser *f. borealis*, Hagen, Loeske. By hot springs *P. fontana* often occurs abundantly both in the lukewarm water and on the warm clayey flats. Here it forms very soft, not cohering tufts. The stems are erect and very slender; the leaves are small, often strongly falcato-secund, longly pointed, highly papillose, and sharply toothed along the margin, with narrow (0.05–0.06 mm. broad) nerve.

Note. *P. calcarea* from Frodarheidi (leg. H. J.) is *P. seriata*.

189. *Philonotis Arnellii* Husnot.

N. Iceland: Hof near Eyjafjörður (O. D.). SW. Iceland: Thingvellir!; between Reykjavík and Hafnarfjörður!.

Near Thingvellir it grew on a soil-covered rock-ledge in a cleft, in association with *Eucalyx subellipticus*, *Bartramia ityphylla* and *Pohlia cruda*. All the specimens found were ♂ plants.

190. *Philonotis seriata* (Mitt.) Lindb.

E. Iceland: Berufjörður!; Seydisfjörður!; Kirkjuból (H. J.)!. N. Iceland: Husavík!, at an elevation of 200–300 metres; several places near Eyjafjörður (O. D.;!); Mývatn (Gr.)!; common in Öxnadalur!. NW. Iceland: Very common by all the fjords from Dýrafjörður northwards!. W. Iceland: Fróðarheidi (H. J.)!; Esja, many places!. S. Iceland: Seljaland (Stp.)!.

Grows on inundated ground, as a rule in the water itself, for instance along streams and in moss bogs.

In NW. Iceland it is one of the most frequently occurring species, and is met with abundantly up to a height of above 400 metres above sea-level. It often forms in association with *Pohlia albicans*, *Scapania uliginosa*, *Haplozia cordifolia* and *Chiloscyphus polyanthus* v. *fragilis* the main portion of the moss-carpet along streams. In the other parts of the country — with the exception of S. Iceland where it has been found only near Seljaland — it is rather common. It is usually met with from about 250 to 500 metres above sea-level, but frequently ascends up to about 600 metres, for instance by Berufjörður. The fruit, which was quite green even in the first half of July, has been found only in a few localities in the district of Isafjörður and near Eyjafjörður, and only scantily.

191. *Philonotis tomentella* Mol.

P. alpicola Jur.

Widely distributed over the whole of Iceland.

P. tomentella usually prefers drier localities than does the closely allied *P. fontana*. In N. Iceland, where it is very common, it grows abundantly everywhere on partially dry, grass-covered ground, and is easily distinguished from *P. fontana* by its more slender growth and by the extremely dense tufts, with stems covered with brown tomentum almost to their summit. It grows, also, both on rather dry and on damp rocks and on wet boggy ground in company with *P. fontana*, with-out, however, extending into the water itself.

It varies very considerably in habit and size. The leaves are more or less falcato-secund, and forms especially from dry rocks have leaves strongly falcato-secund (f. *falcata*). In shady localities, for instance in rock-clefts and caves, slender to almost thread-like forms (var. *capillaris*) are frequently met with. Forms growing in bogs are more vigorous than are those growing on a dry substratum, and are also less densely tomentose.

On damp rocks and in humus-filled rock-clefts there frequently occurs a slender form with numerous slender, easily falling branches which probably serve for vegetative propagation (f. *flagellifera*).

Limpricht (Kryptogamenflora, vol. II, p. 573) records that the

cortex in this species consists of 3—4 layers of sharply defined, small stereids covered with a sphagnoid outer cortex, while *P. fontana* has not a sharply differentiated cortical layer. This feature appears, however, to be closely connected with the degree of dampness of the habitat, so that forms from a dry substratum, both of *P. tomentella* and of *P. fontana*, have several layers of thick-walled cortical cells, while bog-forms have thin-walled cortical cells, and (as in *Dicranum scoparium* and *D. angustum*) all possible transitions may be found between thin-walled and thick-walled cortical cells.

Fruit occurs very frequently and ripens at the end of July or in the beginning of August.

FAM. TIMMIACEÆ.

192. *Timmia norvegica* Zett.

E. Iceland: Hof!; Vallanes (H. J.)!. N. Iceland: Pollar (St.)!; Akureyri!, at an altitude of 300 metres; Hof near Eyjafjörður (O. D.)!; Vidimýri (Gr.)!. S. Iceland: Vestmannaey!.

It grows on earth and in rock-clefts, but has been collected everywhere only scantily. Near Hof (E. Iceland) it grew on gravelly ground in association with *Oncophorus virens*, *Ditrichum flexicaule*, *Myurella julacea* and *M. apiculata* at an altitude of about 150 metres. Near Akureyri it was found sometimes in rock-clefts, in company with *Mnium orthorrhynchum*, sometimes on rocks mixed with *Philonotis tomentella*. Only sterile specimens have been found.

193. *Timmia austriaca* Hedw.

Very common especially in N. and E. Iceland, but more rare in NW. Iceland (Dýrafjörður, Ísafjörður, Grunnavík!). It grows on earth or on soil-covered rocks, and often in masses. Thus in several places in Hallormstádaskógur it was the most abundant member of the moss-carpet under the birches, especially on knolls and soil-covered stones. In several places in N. Iceland, for instance in Öxnadalur, it covered the slopes along streams, often greatly mixed with other species.

Timmia austriaca is most frequent in the lowlands up to a height of about 300—400 metres, but is also often found on mountain heights (for instance on Seljaland at an altitude of about 620 metres) although usually in small quantity. Fruit has been found only near Tverá and Vidimýri in N. Iceland; it occurred plentifully in both places and had just ripened at the end of July.

FAM. POLYTRICHACEÆ.

194. *Catharinea undulata* (L.) Web.

E. Iceland: Hörnafjörður!; Lon!; Berufjörður!. N. Iceland: Hof near Eyjafjörður (O. D.)!; Reykir near Svinavatn (Gr.)!. W. Iceland: Reykja-

vik (Mörch;!); near hot springs in Reykholtdalur (Grl.!); Borgarfjörður!. Common in SW. and S. Iceland!.

Commonly distributed in SE., S. and W. Iceland from Lon in the south-east to Borgarfjörður in the west. In N. Iceland it has been found only near Eyjafjörður, and it has not been collected in NW. Iceland. It grows sometimes on peat, sometimes on damp clayey ground, for instance by sides of ditches, and is occasionally found in fruit, which about Reykjavik was quite undeveloped even in August. It is a decidedly low-land species, and has not been found at a higher elevation



Fig. 9. *Catharinea undulata* (L.) Web. var. *thermophila* (nat. size).

than 50–100 metres above sea-level. The usual forms of this species are low in growth, 1–2 cm. high, with leaves which are as a rule 4–6 mm. long, narrowly lanceolate, obtuse or shortly pointed, only slightly undulate with a few spines at the back, and the margin often with single teeth.

Catharinea undulata is one of the species which is found most frequently and abundantly on warm ground, where it occurs in rather divergent forms. Usually it resembles the southern woodland forms with long, strongly undulating leaves, very rough at the back. A very peculiar form is

Var. *thermophila* n. var.

Loose cushions as much as 10 cm. high. Leaves evenly distributed along the whole length of the stem, or somewhat denser at the top, often falcato-secund, 6–7 mm. long, linear-lanceolate, sharply pointed, with 4–5 lamellæ at the back. Lateral shoots are often developed along

the stems. This form grew abundantly near the 'hot springs about Skálholt, especially on the slopes stretching down towards the outlets of the springs.

195. **Oligotrichum hercynicum** (Ehrh.) Lam.

Oligotrichum incurvum (Huds.) Lindb.

Iceland (Mörch). E. Iceland: Seydisfjardarheidi!. N. Iceland: Ljosa-vatn!, common 350 metres above sea-level and upwards; Askja (Caroc)!. NW. Iceland: Very common!. W. Iceland: Stadarfell (Stp.); Esja!, at an altitude of 400—500 metres; Reykholtalur (Gr!;!); Hafnarfjörður!. S. Iceland: Common from about 350 metres and upwards!; Krisuvík (Stp.)!; everywhere near hot springs!.

This species has a very peculiar distribution in Iceland. It has its main area of distribution on the mountain heights, where it doubtless occurs over the whole of Iceland, and often in masses. It grows here on damp gravelly flats, especially in the neighbourhood of the snow-patches, in association with *Anthelia Juratzkana*, *Pleuroclada albes-cens*, *Pohlia gracilis*, *Polytrichum sexangulare*, etc., and as a rule sets fruit. Scarcely anywhere has it been found until at a height of 350—400 metres, and was most abundant at about 500—700 metres above sea-level. Only in NW. Iceland, where it is exceedingly common, did it descend to a lower altitude, in many places as low as to the sea-level. In the greater part of the country it is quite absent from the low land; in SW. Iceland it has been found only scantily in a lava cave near Hafnarfjörður.

This species has another area of distribution near the hot springs in SW. and W. Iceland. Here it has been collected near a great number of springs in Reykholt- and Reykirdalur, around Skálholt and in several other places, where it often occurs abundantly on the warm clayey flats, but only sterile. These warm-soil forms differ somewhat from the Alpine forms. As a rule they are quite low in growth, about 5—10 mm. high, with softer leaves, twisted or incurved when dry, with a few (5—6) lamellæ at the back. The leaf-cells are more thin-walled, chlorophyllous, larger and more regularly quadrate and transversely elongated, usually 0.015—0.018 mm., but occasionally also 0.025 mm. in diameter, shortly rectangular at the base, 0.018 mm. broad. The nerve is often only half as broad as in the Alpine form. Such forms grow especially on the warm clayey flats, in company with *Anthoceros*, *Fossombronia*, *Haplozia crenulata* and other hepatics. Near Deildartunguhver in Reykholtalur it grew on the warm ground among other mosses, in tufts about 3 cm. high. Forms exactly resembling the Alpine forms occur also frequently on the warm ground.

In the majority of the localities in NW. Iceland the fruit was ripe in the latter half of June, on the mountain heights early in July.

196. *Psilopilum lævigatum* (Wahlb.) Lindb.*Oligotrichum glabratum* Lindb.*O. lævigatum* Br. eur. *Psilopilum arcticum* Brid.

E. Iceland: Hornafjörður!; Berufjörður!; Seydisfjörður!. N. Iceland: Husavik!; Akureyri!; Hof near Eyjafjörður (O. D.)!; Geitaskard!. NW. Iceland: Isafjörður!; Snæfellsströnd!. W. Iceland: Stykkisholmur!; Stadarfell (Stp.)!; Hafnarfjörður!; Reykjavik (Mörch; Ho.; Stp.;!). S. Iceland: Common in Ölfus!.

Commonly distributed everywhere near the coasts. It grows there on rather dry peaty ground, and often in great abundance. For instance near Reykjavik it covers in association with *Dicranella crispa*, *Bryum pallens*, *Scapania curta*, etc. large tracts of ground on the peninsula. It appears to thrive more particularly in drained bogs whence peat is being cut; thus around Husavik, Akureyri and Isafjörður it occurred in very great abundance, partly on the ground and partly on the piled up heaps of cut peat, which were often quite covered by it. *Funaria hygrometrica* and *Pogonatum urnigerum* often occurred abundantly in company with it. Fruit ripens in the beginning of (Reykjavik) or at the end of June (N. Iceland).

Note. F. Hagen in his preliminary works on a Frondose-Moss Flora of Norway (XIX, *Polytrichaceæ*) supposes that *Psilopilum tschutschicum* (Müll. Hal.) Par. has been collected in Iceland by W. F. Hooker. All the specimens I have had an opportunity of investigating, both numerous older specimens collected by Mörch, Krabbe, Grönlund and others and my own specimens collected in a considerable number of habitats from all parts of Iceland, belong to *Psilopilum lævigatum*, which is doubtless the only species of this genus found in Iceland.

197. *Pogonatum polytrichoides* (L.) Brockm.*Pogonatum nanum* (Schreb.) P. B. *P. subrotundum* Lindb.

Iceland (Ho.; Mörch)!. W. Iceland: Reykjavik (Grl.;!); Stykkisholmur (Stp.)!; Sletta (Stp.); in the district of Borgarfjörður!. S. Iceland: Near the Thjorsá (Stp.)!; frequent in Ölfus!.

This species was found only in SW. and W. Iceland, but was rather common in both places on somewhat damp and especially peaty soil, for instance by the sides of ditches and along roads. In the district of Borgarfjörður it was common along roads. Around Reykjavik it was found everywhere by the sides of ditches. Fruit was found everywhere, the capsules were partly old specimens from the previous year and partly such as were quite young even in August.

Note. *Pogonatum aloides* (Hedw.) is recorded to have been collected by Steenstrup near Sletta, Stykkisholmur and the Thjorsá, but all the specimens belong to *P. polytrichoides*.

198. **Pogonatum dentatum** (Menz.) Brid.Var. **minus** (Wahlb.) Hagen.

Reykjavík!.

Here it grew in several places on peaty soil, and in one place very abundantly, with numerous capsules, some of which were almost ripe in the first half of August.

199. **Pogonatum urnigerum** (L.) P. B.*Polytrichum urnigerum* L.

Widely distributed over the whole of Iceland.

Grows usually scattered as individual plants, or a few plants together, among other mosses on dry, humus-covered rocks or on the ground, both dry and somewhat damp: for instance along the banks of streams. It occurs in large quantities on peat, often forming large light-green patches, interwoven with *Alicularia scalaris* and, occasionally, *Scapania curta*. On somewhat damp, moss-grown slopes it often forms large tufts several centimetres high among *Hylocomium* spp., *Hypnum uncinatum* and *Polytrichum alpinum*; such vigorous forms are also frequently met with in South Iceland on somewhat damp ground, for instance by the sides of ditches. It is most frequent in the lowlands and does not appear to ascend above 300—400 metres. The fruit, which only occurs on large plants growing in tufts, was ripe or overripe in the beginning of June.

200. **Polytrichum alpinum** L.

Very common everywhere both on dry and on somewhat damp ground, and almost equally frequent from the sea-level up to the limit of vegetation on mountain heights. It grows both mixed with species of *Hylocomium* and interspersed in *Rhacomitrium*-mats on knolls in bogs, on peat, in grass-fields and on the stony slopes of mountain heights. The fruit, which occurs very frequently, ripens in the lowlands about August 1st.

Varies considerably in habit, length of leaf, form of capsule, etc., but the majority of the forms, however, approach closest to the type. Forms agreeing more or less with var. *septentrionale* (Sw.) Brid. are also common.

201. **Polytrichum formosum** Hedw.

W. Iceland: "Sæluhusid" in Sókkólfadalur (F.)!, sterile.

202. **Polytrichum gracile** Dicks.

Rather common over the whole of Iceland.

This species grows in peaty soil, often abundantly, and sets fruit almost always. It occurs only in the low land and has hardly been

found at a higher level than 200—300 metres. Near Akureyri the fruit was ripe at the end of July.

Var. *anomalum* (Milde) Hagen.

Hof near Eyjafjörður (O. D.)!. NW. Iceland: Hesteyri!.

In both these places it was collected scantily only. Near Hof it occurred as a few scattered individuals in a specimen of the vegetation taken from wet boggy ground. Near Hesteyri it grew on very wet boggy ground. The plants were about 3 cm. high and sterile. Some of them agreed with var. *anomalum*; in some the leaves at the base of the stem resembled in structure those of the variety in having thin-walled cells 0.020—0.025 mm. in size, while the leaves in the upper part of the stem resembled in structure those of the type in having cells 0.015—0.020 mm. in size.

Var. *anomalum* is undoubtedly a hygrophilous form of *P. gracile*, which develops when the habitat is inundated.

203. *Polytrichum sexangulare* Floercke.

Iceland (Mörch)!. N. Iceland: Ljosavatn!; Reykjaheidi!; common near Eyjafjörður (O. D.;!). NW. Iceland: Very common!. W. Iceland: Esja!; Kolvidarhol!. S. Iceland: Seljaland!; Holt!; Thingvallahraun!.

Var. *vulcanica* C. Jens.

"Seta perbrevis usque ad 4 mm. longa; apophysis valde indistincta; capsula non angulata, vetusta nigrescens et irregulariter 4—5-gona; Cetero typo simile."

S. Iceland: The volcano on the road to Holt (Stp.)!.

Var. *tenellum* n. var.

Plants 1—2 cm. high, more slender than the type, with shorter, narrower, more slightly incurved and not secund leaves, when dry; the nerve excurrent in a short mucro; otherwise exactly like the type.

S. Iceland: Barkarstadr!; Dráangshlid!; Seljaland!.

Polytrichum sexangulare has a very peculiar distribution in Iceland. The type is a decidedly Alpine plant which does not feel quite at home until near the snow line, on the gravelly flats soaked by the melting snow. In N. Iceland it has been collected only at elevations of above 500 metres. In NW. Iceland, where the species is very common, it is met with everywhere from about 200—300 metres upwards. On northern slopes where the snow lies long it sometimes descends as far down as to the sea-level. Near Kolvidarhol it was common at about 400 metres, and on Esja everywhere at elevations of above 500 metres.

P. sexangulare has not yet been collected in E. Iceland, but the reason can hardly be that it does not occur there, it must rather be due to the fact that the mountain heights were almost everywhere snow-covered at the time of the year (June, 1909) when there was an opportunity of making collections there. This species has an area of distribution not only on the mountain heights, but also in the lowlands.



Fig. 10. *Polytrichum sexangulare* Floercke var. *tenellum*.
a, in a damp, and b, in a dry condition ($\times 6$).

In lava clefts near Thingvellir and in deep lava clefts on Reykjarheidi (at an altitude of about 250 metres) it was found abundantly in several places in association with several other Alpine species, for instance *Gymnomitrium concinnalum*, *G. varians*, *Pleuroclada albescens* and *Pohlia commutata*. The occurrence of this species in such localities is undoubtedly connected with the fact that there the conditions pertaining

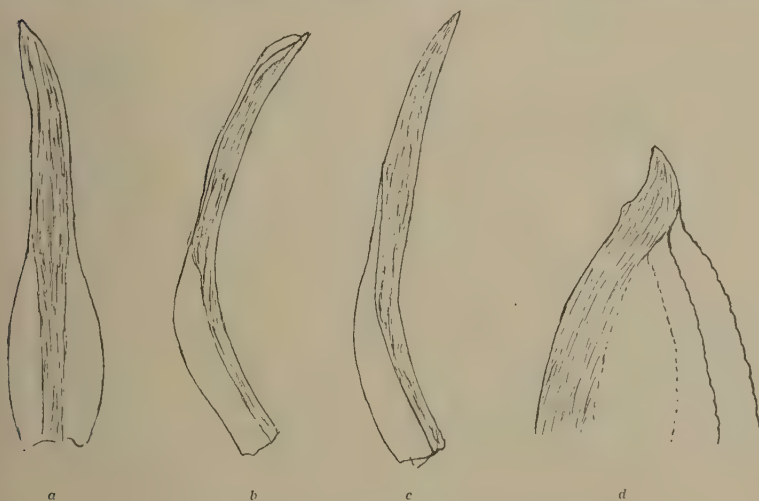


Fig. 11. *Polytrichum sexangulare* Floercke var. *tenellum*.
a, b and c, leaves ($\times 15$); d, leaf-apex ($\times 100$).

to soil present certain points of resemblance to the mountain heights, as the snow in the deep clefts, the bottom of which is never reached by the rays of the sun, often remains till late into the summer. The occurrence of var. *tenellum* is more peculiar. It has been found only in S. Iceland, where it grew exclusively on dry or slightly damp blocks of tuff in the lowlands. But only near Seljaland did a few small tufts occur on a block of tuff at an altitude of about 600 metres. Near Drángshlid it grew abundantly on the fallen blocks of rock at the foot of the rock-wall behind the farm. There in company with *Hypnum cupressiforme*, *Ceratodon*, *Didymodon rubellus*, *Racomitrium fasciculare* and *Bryum argenteum* it formed tufts of varying size on the top of the blocks in dry situations. Near Barkarstadr it was found on a somewhat damp tuff-face, and creeping over fallen blocks of rock, in association with *Pohlia cruda*, *P. grandiflora*, *Anæclangium compactum*, *Bryoxiphium norvegicum* and *Anthelia* spp. The plants from these habitats were quite sterile, and exactly alike in all respects.

The fruit, which is common in the Alpine form, ripens in August (Akureyri: ripe Aug. 13th; near Isafjörður: green in the first half of July).

204. *Polytrichum piliferum* Schreb.

Polytrichum pilosum Neck.

Iceland (Mörch)!. E. Iceland: Vallanes (H. J.;!). N. Iceland: Reykjahlid (Grl.;!). NW. Iceland: Bildudalur (C. Hansen;!). Gnupr near Dyrafjörður!; Ármuli!; Arngerðareyri!. W. Iceland: Stykkisholmur (H. J.;!). Grund in Skorradalur!; common near Reykjavik!; Videy!; Hafnarfjörður (Wiinstedt)!. S. Iceland: Krisuvik (Stp.;!); Drángshlid!.

Occurs here and there, and is rather rare in the majority of the districts of Iceland. It grows on dry sandy ground, upon soil-covered rocks and on dikes, often singly among other mosses. It is absent from or rare in the most rainy parts of the country, for instance at the East coast and in South Iceland and is most frequent in those districts where the rainfall is least. Thus it occurs abundantly near Mývatn, where it is common in the lava-field. It is also rather widely distributed in NW. Iceland, here it is often found in abundance, for instance on sandy fields near Ármuli and on rocks near Arngerðareyri. Fruit is common and ripens in the latter half of June.

205. *Polytrichum juniperinum* Willd.

Commonly distributed.

It grows on more or less dry ground, for instance on knolls in bogs, in the *Racomitrium-canescens* heath, on slopes among *Hylocomium* and *Racomitrium* etc., usually scattered among other mosses, more rarely in cohering tufts, and almost always sets fruit which ripens at the end of June and in the beginning of July (Seydisfjörður, July 6th; Isafjörður, June 24th).

It is most widely distributed in the lowlands and does not appear to ascend much higher than about 400 metres above sea-level.

206. *Polytrichum strictum* Banks.

E. Iceland: Hornafjörður, common!. N. Iceland: Husavík!; Akureyri, common to about 600 metres above sea-level!; Hof near Eyjafjörður (O.D.)!; common from Geitaskard westwards to Hrutafjörður!. NW. Iceland: Common around Ísafjörður!; Grunnavík!; Kaldalon!. W. Iceland: Grund in Skorradalur!; Ólafsdalur (H. J.)!; Reykholtalur, common!; Reykjavík!. S. Iceland: Skálholt!, ♂; Geysir (Stp.)!.

Occurs rather commonly and often abundantly on wet boggy ground, but always sterile. In Reykholtalur it also grows on warm ground.

207. *Polytrichum commune* L.

Widely distributed on damp ground, both in bogs and along the banks of streams, but as a rule rather scantily.

In the low land, where *P. commune* has its greatest distribution, the large coarse form is usually met with. In higher regions, where it is found up to a height of about 500 metres, it usually becomes slenderer and lower in growth. Thus, near Akureyri, it occurred abundantly in a bog at an altitude of 500 metres as a low-growing, slender form, mixed with *Hypnum stramineum*.

P. commune is one of the most frequent species near hot springs, where it grows sometimes mixed with *Sphagnum* and is then large and vigorous, sometimes in extensive mats interwoven with hepatics and is then usually low in growth with shorter leaves. On a warm substratum it often fruits freely, while it has or else been found in fruit only near Grunnavík in NW. Iceland.

Var. *fastigiatum* (Lyl.) Wils.

SW. Iceland: Svinahraun!, abundantly on damp soil at the edge of the lava-field.

208. *Polytrichum Swartzii* Hartman.

NW. Iceland: Bæir!, sterile.

Var. *nigrescens* (Warnst.) Hagen. Syn. *Polytrichum inconstans* Hagen.

NW. Iceland: Thoroddstadaengjar (St.)!; Dýnjandi!.

The type grew on a damp slope in not-coherent tufts, about 15 cm. high: the plants were quite typical with sharply toothed leaves, and with lamellæ, the marginal cells of which had the irregular form peculiar to *P. Swartzii*. The variety grew on very wet or inundated ground in company with *Hypnum stramineum*, *H. giganteum* and *Mnium cinclidioides* similarly to *P. gracile* var. *anomalum*, and may be regarded as a form similar to the latter; as in aquatic forms of other species, both forms have flaccid-soft leaves with slightly developed stereom in the nerve and broader, slightly toothed leaf-margin; in the plant from Dýnjandi the leaf-margin was almost entire.

FAM. BUXBAUMIACEÆ.

209. *Diphyscium sessile* (Schmid.) Lindb.*Webera sessilis* Lindb.

Common in East, South and West Iceland, and rather frequent in North-west Iceland, where it is common for instance in the district of Dýrafjörður. In North Iceland it has not been found east of Blóndudalur.

It grows on firm, bare ground, especially on the top of knolls or on small elevations of earth on slopes, where it forms low, dense cushions, dark brown in colour; it is common, at any rate in E. Iceland, as far upwards as 600–700 metres above sea-level. Fruit, which occurred only scantily in all places, was collected near Reykjavik, near Lundur in West Iceland and near Geitaskard in Blóndudalur.

FAM. FONTINALACEÆ.

210. *Fontinalis antipyretica* L.

Found in all parts of the country and common on stones in brooks and rivers, and sometimes also in stagnant water, up to about 300–400 metres above sea-level. Near Ljosavatn in N. Iceland it was found abundantly in a river even at an altitude of 300–400 metres, and near Isafjörður it occurred frequently as far upwards as 300 metres. It varies considerably in size, leaf-form and colour. In stagnant water (thus in very wet bogs near Jökulsfjörður) it becomes very robust, light brownish-yellow, with broad leaves.

In swiftly flowing water there often occur slender, dark-green or brownish-green forms with strong metallic sheen, which agree most closely with var. *montana* H. Müller. In such forms the basal angles of the leaves are often somewhat concave, and formed of a single layer of cells, in which respects it comes very near to *F. gracilis*. This species is recorded from several localities by Grönlund, H. Jónsson and Feddersen, but all the specimens which have been investigated belong either to *F. antipyretica* or to *F. androgyna*. Only sterile specimens have been found.

211. *Fontinalis islandica* Cardot.

E. Iceland: Faskrudsfjörður (Jardin, 1865) (specimens not inspected).

212. *Fontinalis longifolia* C. Jensen (Bot. Not. 1885, p. 83).

"Gracilis, viridis et flavoviridis, elongata, mollis, rubricaulis, ramulis brevibus, patulis subremotis. Folia laxa, imbricata vel erecto-patentia mollia, carinata, annosiora, bifida, ovato-lanceolata, sensim longe acuminata, integra vel ad apicem lenissime serrulata, decurrentia, cellulis

flexuoso-linearibus, apicalibus brevioribus, angulorum multo majoribus, rectangulis. Folia ramulorum angustiora. Flores et fructus ignoti."

This species, which was first found by Feddersen in the Helgá in S. Iceland, grew very abundantly on stones in the Reykirdalsá in SW. Iceland. This river has copious influx from the hot springs, so that, in the first days of June, the temperature of the water was about 12° , which was essentially higher than in the majority of the other rivers where the temperature was, as a rule, only about 4° – 6° .



Fig. 12. *Fontinalis longifolia* C. Jens. (Reykir; somewhat reduced).

Fontinalis longifolia agrees most closely with *F. hypnoides* R. Hartm. The plant from the Reykirdalsá is rather robust, as much as 25 cm. long, very strongly and irregularly branched, with rhizoid-cushions around all the points whence the branches issue, and with plane or somewhat concave, longly tapering, very soft leaves, which only exceptionally are folded along the median line. The ♂ plant is more slender than is the ♀ plant, with very numerous, narrowly ovate ♂ flowers, which often occur in clusters of 2–4 on the main axis and branches and contain each 2–4 antheridia. The fruit, which in the beginning of June was developed to almost full size, but was as yet quite green, so that the peristome and spores could not be investigated, was found scantily on the lowermost part of the stem. As in *F. hypnoides* the capsule was half-exserted.

213. *Fontinalis thulensis* C. Jensen (Bot. Tids. 20, p. 110).

"Laxe caespitosa, sat robusta, mollis, sordide luteola, inferne nigrescens subnitida. Caulis usque ad 25 ctm. longus, inferne plerumque nudus, plus minusque ramosus, ramis brevibus vel elongatis, erecto-patentibus, vel subsecundo-arcuatis, interdum acutis, cauli primario sat similibus. Folia dimorpha, tristicha; folia caulina erecto-patentia vel laxe imbricata, plus minusque distincta et recte carinata, interdum tantum complicata, late ovata-lanceolata, longe decurrentia integra vel apice indistincte denticulata, adultiora subobtusata, juniora acuta, nunquam bifida, superiora vulgo 5—6 mm. longa et 2—3 mm. lata, inferiora minora, latere uno versus basim reflexo; folia ramulina minora et subangustiora, vulgo 3—4 mm. longa et 1,5—2 mm. lata, inferiora multo minora omnia ecarinata, valde concava, interdum complicata, erecto patentia, inferiora ramorum arcuatorum arcte imbricata, superiora interdum subsecunda. Cellulae in media foliorum 0,007—0,013 mm. latae, 8—12 plo longiores. Alae basilares, planae, unistratae, e cellulis quadratis et hexagonis, aequae ac ceteris cellulis basilaribus, luteis formatae. Cetera ignota.

Speciei americana *F. Kindbergii* valde affinis, sed ramis erecto-patentibus, non pennatis, foliis eorum brevioribus et latioribus, cellulis angustioribus, colore luteolo (*F. Kindbergii* ferrugineus est) et nitore debiliore."

W. Iceland: The Laxá (Hjarðarholt), 21.7.1886 (Feddersen).

Note. *Fontinalis squamosa* L. is enumerated on older lists, but of the specimens from Iceland, contained in the collections, some belong to *F. antipyretica*, some to *F. androgyna*.

214. *Fontinalis androgyna* R. Ruthe.

W. Iceland: The Ellidará near Reykjavik (Mörch; Grl.; H. J.;!).

In the Ellidará it grew abundantly in company with *F. antipyretica* on large stones and rocks under water. There not only ♂ buds were found, but also a few ripe capsules on the lowermost part of the stem (5. 8. 1909).

FAM. CRYPHÆACEÆ.

215. *Leucodon sciuiroides* (L.) Schwgr.

S. Iceland: Foss (H. J.); Drángshlid (H. J.); Stjörnarsandur (H. J.); Hrutafell!. SE. Iceland: Hornafjörður!; Hof!. SW. Iceland: Hafnarfjörður!.

All the Iceland specimens belong to var. *morensis* (Schwägr.) de Not. It grows on dry rock-walls with a southern exposure, both on tuff and on basalt, and appears to be rather frequent from Hof in SE. Iceland throughout S. Iceland to Hafnarfjörður in SW. Iceland. It occurred abundantly on Hrutafell and Drángshlid, and covered the vertical faces of tuff-rocks for long distances. Here it was also richly fruiting with capsules which were partly ripe at the end of June.

216. *Antitrichia curtipendula* (Hedw.) Brid.

E. Iceland: Hornafjörður, common!; Djúpivogur!; Hof!; Starmýri!; Berufjörður!. N. Iceland: Möðruvellir (Thóróddsen)!; Geitaskard!; common in Vatnsdalur!. NW. Iceland: Patreksfjörður!; Kaldalon!. Common in W. and SW. Iceland!.

Common in SE. Iceland as far as Berufjörður (where it was found in one locality only), in S. and W. Iceland and the western part of N. Iceland from Blóndudalur. Rare and scanty in NW., N. and E. Iceland. It grows usually on a rather dry substratum, on stony slopes, and soil-covered rocks, but especially on moss-grown slopes in company with *Hylocomium* spp., and on the ground in coppices. In Esja it is common up to a height of 300–400 metres above sea-level. Only sterile specimens have been found.

FAM. NECKERACEÆ.

217. *Neckera complanata* (L.) Hüb.

W. Iceland: Gilsbakki!; Bardshellir (Gr!.)!. S. Iceland: Paradishellir (Stp.)!; Reykir!; Austarhlid near Geysir!; Breidabolstadr!; Barkarstadr!; Holt!; Drángshlid!; Hrutafell!.

Rare in W. Iceland, and rather common in S. Iceland. It grows everywhere on the roof and sides of dry caves, which it often covers with its extensive, dark-green mats. Only sterile specimens have been found.

FAM. LESKEACEÆ.

218. *Myurella julacea* (Will.) Br. eur.

Very common on rocks, especially in humus-filled clefts; occasionally also on the ground, for instance on knolls in bogs. It often occurs in unmixed cushions, but far more frequently mixed with other mosses, and is met with both on a dry and on a somewhat damp substratum. On wet rocks it often grows in association with *Anectangium Mougeottii*, *Philonotis*, *Blindia acuta*, etc.; in dry clefts in company with *Mnium orthorrhynchum*, *Plagiothecium Roeseli*, *Bartramia ityphylla*, *Pohlia cruda*, etc.; or it may be met with on dry rocks woven into the tufts of *Hypnum revolutum* and *Grimmia* spp. It does not appear to ascend higher than 300–400 metres. Only sterile specimens have been found.

219. *Myurella tenerrima* (Brid.) Lindb.

Myurella apiculata (Hübén.) Br. eur.

Grows quite similarly to the preceding species and, as a rule, in company with it, and in the majority of the districts of Iceland is almost as common. In S. Iceland it appears, however, to be somewhat

rarer. It is most frequent in rather damp situations, for instance on rocks near waterfalls. Only sterile specimens have been found.

220. **Leskea nervosa** (Schwägr.) Myrin.

SE. Iceland: Hof!, on rocks in company with *Metzgeria furcata*, sterile. S. Iceland: Drángshlid!; Hrutafell!, sterile. In both the latter localities it occurred abundantly on dry tuff-faces or on large fallen blocks.

221. **Leskea catenulata** (Brid.) Mitten.

Nupsdal (Stp.)!.

Here, Gnupsdalur near Dýrafjörður in NW. Iceland is probably meant.

222. **Anomodon viticulosus** (L.) Hook. et Tayl.

S. Iceland: Hrutafell!; cave near Skógafoss!. Vestmannaey!.

On Vestmannaey it grew at the foot of a dry, stony slope below Stora Klit; near Hrutafell it grew sometimes on rocks, sometimes on soil-covered rock-ledges. Only sterile specimens have been found.

223. **Pterigynandrum filiforme** (Timm) Hedw.

Very common everywhere.

The most frequent form is var. *decipiens* (W. et M.) Limpr., which occurs abundantly everywhere on dry rocks, especially on perpendicular basalt-faces, where it often forms very large cushions 5–6 cm. deep. Here all transitional forms are also met with between the type and the variety. The type is developed in deeper shade and occurs especially in clefts and crevices, where it forms thin, adherent mats on the surfaces of stones. Only sterile specimens have been found.

Both forms are common up to about 300–400 metres above sea-level.

224. **Lescuræa decipiens** (Limpr.)

Ptychodium decipiens Limpr.

E. Iceland: Berufjörður!♀, at an altitude of 80 metres.

var. *crassirete* n. var.

Leaf-cells very thick-walled, highly porous and distinctly papillose in the upper half of the leaf. Nerve very strong, 0.040–0.045 mm. broad for almost its entire length.

NW. Iceland: Gnupsdalur, at an altitude of 280 metres!.

L. decipiens is closely allied to *L. saxicola* and is often difficult to distinguish from the latter species. Peculiar to both are the narrow, highly thickened and porous leaf-cells, which in *L. decipiens* are more or less distinctly papillose with a papilla at each of the uppermost cell-angles, at the back towards the leaf-apex; while *L. saxicola* almost always has quite smooth leaves. In *L. saxicola* the upper half of the

leaf-margin is almost straight in outline, while in *L. decipiens* it is distinctly concave, as in *L. filamentosa*.

The variety grew abundantly on somewhat damp rocks; it is somewhat coarser and less branched than the type which it resembles exactly in leaf-form and size of the cells. The leaf-cells in this form are so highly thickened and porous that the walls almost appear like a string of beads and are often broader than the cell-space.

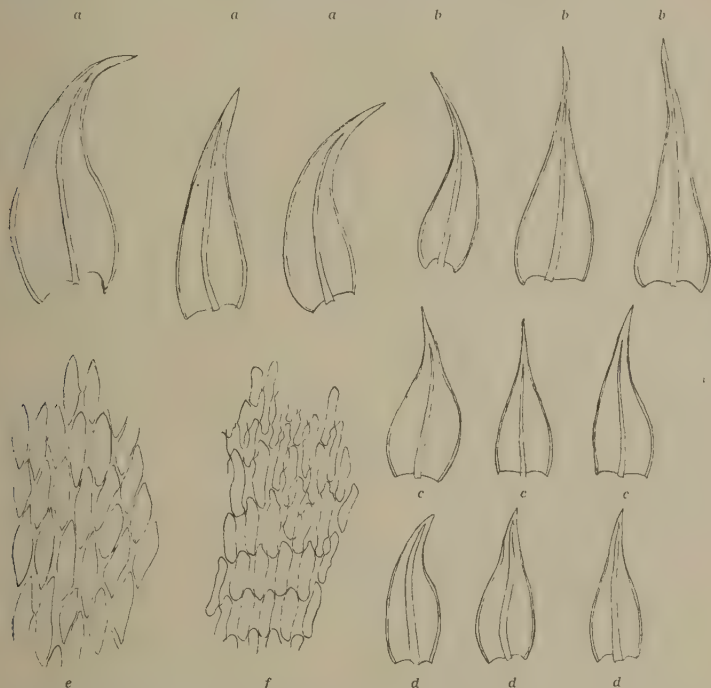


Fig. 13. *a*, Leaves of *Lescuræa Breidleri* ($\times 20$); *b*, leaves of *L. radicata* ($\times 20$); *c*, leaves of *L. decipiens* ($\times 20$); *d*, leaves of *L. decipiens* v. *crassirete* ($\times 20$); *e*, leaf-cells of *L. decipiens* ($\times 320$); *f*, leaf-cells of *L. decipiens* v. *crassirete* ($\times 320$).

225. *Lescuræa radicata* (Mitt.) Hagen.

Lescuræa rigescens (Wils.) Br. eur.; *Pseudoleskea radicata* (Mitt.) Lindb.
Ptychodium Pfundtneri Limpr.

N. Iceland: Öxnadalur, Tverá!; sterile.

In the above locality it grew scantily on a stone by the river.

226. *Lescuræa filamentosa* (Dicks.) Lindb.

Pseudoleskea atrovirens (Dicks.) Br. eur.

Widely distributed.

Grows on stones and dry or somewhat damp rocks, and appears to be frequent, although not abundant, in all parts of the country up to about 300 metres above sea-level. In NW. Iceland it is very common on stony slopes, and is often richly fruiting while it has or less been found sterile only.

227. *Lescuræa Breidlerii* (Kindb.) Arn. et Jensen.

Ptychodium oligocladum Limpr.

E. Iceland: Berufjardarskard!, at an altitude of 600 metres; Seydisfjörður!, 500 metres. N. Iceland: Reykjahlid!; Akureyri, at an altitude of about 770 metres!. Grimsey (O. D.)!; Öxnadalsheidi (Gr.)!. NW. Iceland: Dýrafjörður!; Gnupsdalur!; Isafjörður!; Sugandafjörður!; Grunnavík!. S. Iceland: Barkarstadr!, at an altitude of 530 metres.

Frequent on rocks and stones in the more highly situated parts of the country. It occurs in greatest abundance and in its most typical form on mountain heights at elevations of above 500—600 metres, where it is often the most abundant constituent of the vegetation. It has its main distribution in NW. Iceland, where, for instance around Isafjörður and Sugandafjörður, it occurs very abundantly on the rocky flats from about 200 metres upwards. ♀ plants are common, ♂ plants and fruit have not been observed.

Lescuræa filamentosa and *L. Breidlerii*, judging from the Iceland specimens, are well-defined forms which, as a rule, may easily be distinguished from each other.

L. filamentosa is the lowland form, which has its main distribution in the birch region, and does not ascend much higher than about 300 metres above sea-level. Here it forms low, dense, dark-green or blackish-green tufts on stones, and prefers somewhat damp localities. ♂ plants are very frequent, ♀ plants occur more rarely.

L. Breidlerii is the Alpine form, which descends only by exception to the upper limit of the birch region. It forms deep, loose, yellowish tufts of great extension upon the dry stony slopes of the mountain heights, or upon large blocks of rock. Only sterile ♀ plants have been found. Both the habit and the colour easily distinguish the two species from each other. *L. Breidlerii* is almost branchless, but with some long, ascending branches often hook-shaped at the apex; *L. filamentosa* is densely and irregularly branched. In its most lowly situated habitats, for instance near Reykjahlid at an altitude of about 300 metres, and in some localities in NW. Iceland, *L. Breidlerii* shows, however, a tendency to develop forms which approach in habit the vigorous forms of *L. filamentosa* var. *brachyclados*. The leaf-cells in all the investigated specimens of *L. filamentosa* were short, oval or roundish and thick-walled, more or less but always distinctly papillose, frequently as far down as to the leaf-base, the nerve was very rough at the back, which features most certainly distinguish doubtful forms from *L. Breidlerii*. In the latter species the leaf-apex is longer, the nerve is narrower towards the apex and usually smooth, rarely indistinctly toothed at the back. The leaf-tissue in *L. Breidlerii* is much more translucent than in *L. filamentosa*.

and is formed by prosenchymatous cells 0.008–0.009 mm. broad and 3–4 times, at the apex about 6 times, as long, which are, as a rule, quite smooth, more rarely slightly papillose towards the leaf-apex. The leaf-margin in *L. Breidlerii* is revolute for almost its entire length, so that only the apex itself is plane. In *L. filamentosa* the leaf-margin is sometimes plane, sometimes more or less revolute, and on the same plant leaves may be found with margins either quite plane or revolute to the apex, which effaces the difference between the type and the variety *brachyclados* (Schwägr.) Br. eur. This form, which occurs rather frequently in somewhat damp habitats, forms in several respects a transition to *L. Breidlerii*, and has, as the latter, a well-developed central strand, while the usual forms of *L. filamentosa* never have a central strand.

228. *Lescuræa patens* Lindb.

Pseudoleskea patens (Lindb.) Limpr.

E. Iceland: Berufjörður!, ♀, 500–600 metres above sea-level. N. Iceland: Grimsey (O.D.)! (fr.). NW. Iceland: Gnupsdalur near Dýrafjörður! fr.; Dýnjandi! ♂. W. Iceland: Reykjavík!; Kollafjörður! ♂; Möðruvellir!, in several places up to a height of about 200 metres, ♂. S. Iceland: Barkarstadr, about 460 metres above sea-level.

Lescuræa patens appears to be rather widely distributed in all parts of Iceland. It is met with from the low land to high up in the Alpine region on somewhat damp, shady rocks or damp stony slopes, often very abundantly. Thus, in Gnupsdalur it occurred in masses on stony slopes from about 250–400 metres, in association with *L. filamentosa*, *L. Breidlerii*, *Pohlia commutata*, *Brachythecium reflexum* and *Lophozia* spp.; and with numerous fruit which had just ripened on June 19th. Near Reykjavík it grew on the ground among large stones in a damp meadow, in company with *Schistidium gracile*.

Note. *Ptychodium plicatum* (Schleich.) Schimp. is recorded by Grönlund from Grimstunga and Reykjavík. The plant from Grimstunga is only a form of *Brachythecium albicans*, and that from Reykjavík of *Camptothecium lutescens*.

229. *Heterocladium squarrosulum* (Voit) Lindb.

Heterocladium dimorphum (Brid.) Br. eur.

E. Iceland: Berufjörður!; Hof!. N. Iceland: Mývatn (Gr!.)!; Ljosa-vatn!; Hof near Eyjafjörður (O.D.)!. SW. Iceland: Thingvallahraun!; Kollafjörður!. S. Iceland: Kihlhraun!.

Occurred here and there on dry ground, especially on moss-covered slopes or in birch coppices. Near Hof in E. Iceland it grew on a stony slope (about 100 metres above sea-level) covered with *Hylocomium* spp. and *Rhacomitrium*. In Thingvallahraun it was found associated with *Hypnum uncinatum*, *Pohlia nutans* and *P. acuminata* on a small slope in the birch coppice. Only sterile specimens have been found.

230. *Thuidium tamariscinum* (Hedw.) Br. eur.

Vestmannaey: HeljUSDalur and Stora Klit!. S. Iceland: BarkarstaDr!; Holt!; Seljaland!.

Gliemann records that this species was found by Mörch, but there are no specimens of it in the collections.

This species was found only in the southernmost part of Iceland, where it is frequent in several places on Vestmannaey and along the whole stretch of country south of Eyjafjall. Here it grows especially in the clefts at the foot of rock-walls or among large stones. Near Seljaland it was found abundantly on slopes stretching down towards the Seljalandsá, associated with *Thuidium delicatulum*, *Camptothecium lutescens*, *Scleropodium purum* and *Hylocomium* spp.

231. *Thuidium delicatulum* (Dill., L.) Mitten.

NW. Iceland: Dýrafjörður (Hartz)!. W. Iceland: Esja!. S. Iceland: Reykirdalur!; Skálholt!; BreidabolstaDr!; BarkarstaDr!; Seljaland!; Holt!; Drángshlid!. SE. Iceland: Hornafjörður!.

Common from Hornafjörður in SE. Iceland throughout the whole of S. and SW. Iceland to Hvalfjörður. There it grew on grass-covered slopes, especially on somewhat damp ground, up to a height of about 200—300 metres; occasionally also on more damp meadow land. Near BarkarstaDr it was common even at an altitude of about 320 metres.

T. delicatulum becomes especially luxuriant on warm ground. By the hot springs near Skálholt it grew abundantly in cushions almost 10 cm. deep, associated with *Hypnum stramineum*, *H. Lindbergii* and *Hylocomium squarrosum*. Only sterile specimens were found.

232. *Thuidium Philiberti* Limpr.

SE. Iceland: Hornafjörður!. SW. Iceland: Álafoss!. S. Iceland: Reykirdalur!; Holt!; Vestmannaey!.

This species has a quite similar distribution to, and often grows in company with, *T. delicatulum* from which it cannot be distinguished in the field. Near Álafoss it grew on boggy ground along the river. In Reykirdalur it was common on rather dry, moss-grown slopes; it was also common around Holt, south of Eyjafjall.

Thuidium Philiberti is a weak species which in a sterile condition can be distinguished from *T. delicatulum* only by the length of the leaf-apex; the length varies considerably, however, in the Iceland plants, leaves being sometimes found in which the apex is elongated hair-shaped with 4—5 cells, and sometimes such leaves in which the apex consists only of a single cell or of two. Only sterile specimens have been found.

233. *Thuidium abietinum* (Dill., L.) Br. eur.

E. Iceland: Hof!; Vallanes (H. J.;!). N. Iceland: Akureyri (Gr!.;!); Hof near Eyjafjörður (O. D.); Mývatn!; Viðimýri (Gr!.;!); Tverá in Öxnadalur!. W. Iceland: Esja!. S. Iceland: BarkarstaDr!; Vestmannaey!.

Occurs here and there on dry stony or moss-grown slopes up to about 200 metres above sea-level, especially in N. Iceland, where it is rather common in many districts (around Eyjafjörður, in Óxnadalur, etc.).

234. **Thuidium lanatum** (Strömgr.) Hagen.

Thuidium Blandowii (W. et M.) Br. eur.

Very common from Höskuldstaðr in E. Iceland throughout N. and W. Iceland to Borgarfjörður. In NW. Iceland it occurs here and there, for instance near Ísafjörður, Kaldalon and Dýnjandi near Jökulsfjörður, but everywhere scantily only. In E. Iceland it has not been observed south of Berufjörður, and in W. Iceland it appears to be absent from the south of Borgarfjörður. In S. Iceland it has been found rather plentifully near Holt and Barkarstaðr.

T. lanatum grows almost always in bogs, where, especially in N. Iceland, it is often the most abundant constituent of the vegetation. It is more rarely met with on wet, soil-covered rocks. It is most frequent in the lowlands up to about 300 metres; but near Akureyri it is frequent even at a height of 400—500 metres above sea-level, and near Barkarstaðr up to about 400 metres. Fruit, which occurs everywhere, ripens in the first half of July.

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235. **Orthothecium rufescens** (Dicks.) Br. eur.

Stereodon rufescens (Dicks.) Mitt.

W. Iceland: Melar (Grl.)!, sterile.

236. **Orthothecium intricatum** (Hartm.) Br. eur.

Stereodon subrufus (Wils.) Lindb.

N. Iceland: Skagafjörður (Grl.)!; Thrastarhólsárgil near Eyjafjörður (O. D.)!. S. Iceland: Breidabolstaðr!; Skógafoss!; Vestmannaey! SE. Iceland: Hornafjörður!.

On Vestmannaey it grew rather plentifully, sometimes on blocks of rock in Heljusdal, sometimes on damp slopes intermixed with other mosses. In the other stations it usually occurred on damp rocks, especially on tuff; thus on the sides of a cave near Skógafoss, and near Hornafjörður on the damp rock-faces near a waterfall.

237. **Orthothecium chryseum** Schwägr. (Br. eur.)

Stereodon chryseus Mitten.

Very common in E. and N. Iceland, rather scanty in NW. Iceland (Dýrafjörður and Sugandafjörður). In W. Iceland it was only found

rather scantily in Botnsdalur and in a few localities in Esja, and in S. Iceland it has not yet been observed.

It grows on a damp substratum, both on rocks and on soil up to about 400 metres above sea-level. Thus in N. and E. Iceland it is one of the most frequent species on wet gravelly ground. Only sterile specimens have been found.

238. **Cylindrothecium concinnum** (de Not.) Schimp.

Entodon orthocarpus Lindb.

N. Iceland: Vididalr (Gr.)!. S. Iceland: Vtri Skógar (H.J.)!.

239. **Climacium dendroides** (L., Dill.) W. et M.

Very common over the whole of Iceland.

Grows on damp substrata of every kind, especially in bogs, scattered among other mosses, but also on soil-covered rocks and damp gravelly ground; frequent also on more dry ground among grass. It hardly ascends higher than about 300 metres. Fruit was found only in E. Iceland below Fjardarheidi.

240. **Isothecium myurum** (Pollich) Brid.

SW. Iceland: Hafnarfjörður!. S. Iceland: Holt!; Hrutafell!; Drángshlid!; Vestmannaey!.

This species was only found in the south-western part of the country, where it was, however, rather frequent; and in the district south of Eyjafjall it was abundant in several localities, especially near Drángshlid, where it grew abundantly at the foot of perpendicular tuff-rocks facing south. Only sterile specimens have been found.

241. **Isothecium tenuinerve** Kindb.

Isothecium myurum var. *piliferum* C. Jens.

E. Iceland: Papey (St.)!. NW. Iceland: Dýnjandi!; Arngerdareyri!. W. Iceland: Stykkisholmur!; Budahraun (H.J.)!; the hot springs near Reykjavík (Gr.)!; Videy!; Esja!; Hafnarfjörður!; the lava-fields around Reykjavík!. S. Iceland: Holt!; Thingvellir!; Kíhlhraun!; Krisuvík (Stp.)!.

Common in the southern and south-western parts of the country in lava caves and clefts, probably also common in W. Iceland. In NW. Iceland rarer; and only found in one locality in SE. Iceland. Occurs in greatest abundance in lava clefts, for instance abundantly near Thingvellir. Only sterile specimens have been found.

242. **Homalothecium sericeum** (L.) Br. eur.

Very common over the whole of Iceland.

Grows on dry, more rarely on damp rocks, and often abundantly

in very extensive mats. It ascends to a height of about 400 metres above sea-level, and, for instance in Esja, is found abundantly even at an elevation of between 300—400 metres. on dry, steep rock-ledges. Fruit was found only near Breidabolstadr in S. Iceland, and in July it was empty of its spores.

243. **Camptothecium lutescens** (Huds.) Br. eur.

Hypnum lutescens Huds.

Iceland (Wiinstedt)!. N. Iceland: Hnukr in Vatnsdalur (St.)!; common near Geitaskard in Blóndudalur!. NW. Iceland: Dýrafjörður!. W. Iceland: Breidabolstadr!; Lundur!; Esja!; Reykjavik (Gr.)!. S. Iceland: Common!; Vestmannaey!; E. Iceland: Djupivogur!; Hornafjörður!.

Common in the southern and western parts of the country from Hornafjörður in East Iceland to Blóndudalur in North Iceland. It has not been found in the remaining part of North Iceland or in the greater part of East Iceland from Berufjörður northwards, and it is rare in North-west Iceland. It usually grows on dry, stony or grass-covered slopes or in coppices, occasionally also on rocks, but hardly extends higher than 200—300 metres.

The leaves in this species have occasionally in their upper part cells which are shorter, and the angles of which are more or less distinctly shaped like a papilla. This is most distinctly seen in the forms from Reykjavik and Djupivogur, both of which grew on rocks.

244. **Camptothecium nitens** (Schreb.) Schimp.

Hypnum trichoides Neck., Lindb.

Very common.

One of the most frequent mosses on wet rocks. It occurs also frequently on soil-covered rocks or on more dry ground mixed with other mosses. In bogs it often forms the bulk of the vegetation and very frequently sets fruit, which ripens in the beginning of July. It occurs most frequently and abundantly in the low land, but ascends, however, to 400—500 metres above sea-level.

The tomentose form is by far the most frequent. The smooth form, var. *atrichum* Kindb., appears to grow especially on rocks. It was found abundantly on soil-covered rocks close to the coast below Geithellir in E. Iceland.

245. **Brachythecium Mildeanum** (Schimp.) Schimp.

E. Iceland: Seydisfjörður (H. J.)!; Hamarfjörður!. SW. Iceland: Alafoss!.

On wet boggy ground; near Hamarfjörður it grew abundantly on inundated ground along the river.

246. **Brachythecium salebrosum** (Hoffm.) Br. eur.*Hypnum plumosum* Huds.

Commonly distributed in all parts of the country.

This species grows, as a rule, on rather dry ground, for instance on grass-covered slopes and on stones; occasionally also on damp ground, but everywhere scantily only and usually mixed with other mosses. It is most frequent in the low land; near Akureyri it has, however, been found at an elevation of about 500 metres, and near Seydisfjörður about 400 metres above sea-level. Fruit has been found only near Reykir in S. Iceland.

247. **Brachythecium collinum** (Schleich.) Br. eur.

W. Iceland: Esja, Mödruvellir!, on damp rocks at an altitude of about 100 metres.

The form collected here differs in its somewhat more longly pointed stem-leaves and narrower, more slightly toothed, branch-leaves.

Note. *Brachythecium plumosum* (Sw.) Br. eur. is recorded by Grönlund from several localities, but all the specimens of it in the collections have been wrongly determined and the majority of them belong to *Hypnum palustre*.



Fig. 14. *Brachythecium longipilum*. Habit (× 3).

248. **Brachythecium longipilum** n. sp.

Monoicum. Flores masculini in cauli primario numerosa, antheridiis c. 10 sordide flavis et paraphysibus paucis. Cespites humiles, densi

saturate virides, habitu fere formæ gracilis *Brachythecii velutini*. Caulis repens, dense tomentosus, 2—3 cm. longus, 0.25 mm. crassus, ramos erectos numerosos, 4—5 mm. longos emittens. Folia caulina non decurrentia e basi late ovata vel triangulo-cordata in cuspidem longissimum

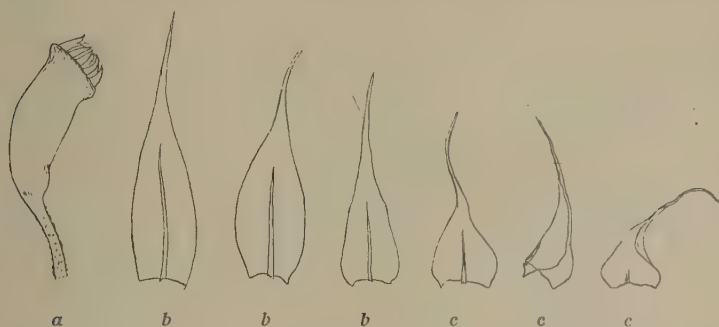


Fig. 15. *Brachythecium longipilum*. a, Capsule ($\times 20$); b, branch-leaves ($\times 20$); c, stem-leaves ($\times 20$).

et tenuissimum recurvatum producta, per totam marginem denticulata, 1—1.2 mm. longa, 0.4—0.6 mm. lata, costa brevi et indistincta. Folia ramorum erecto-patentia aut subsecunda, lanceolata, longius acuminata, 1.4—1.6 mm. longa, 0.4—0.6 mm. lata, per totam marginem denticulata,

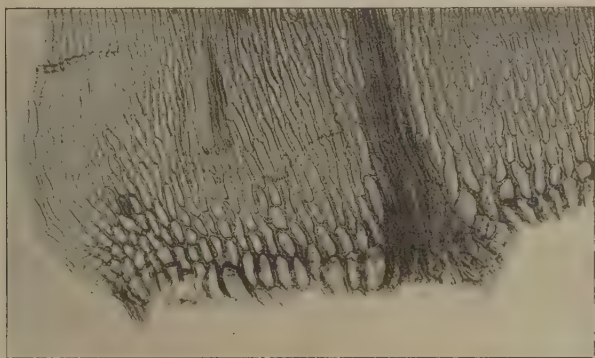


Fig. 16. *Brachythecium longipilum*. Leaf-base ($\times 175$; phot.).

costa mediam partem folii paulo excedente. Cellulæ angustæ, sinuatæ, 0.004 mm. latæ, 0.060—0.075 mm. longæ, basilares in uno vel duo seriebus, ovals, porosæ, pachydermiæ, 0.010 mm. latæ, in angulis quadratæ vel ovals, paucæ.

Perichætium e cauli primario egressum. Folia perichætialia exteriora apice brevi, interiora apice longo reflexo, ecostata vel costa perbrevis et

indistincta, margine leniter dentato. Seta 8 mm. longa, c. 14 mm. crassa, purpurea, in dimidia parte superiori rugosa, inferne glabra. Capsula fusca, obliqua, longe ovata, operculata 1.7 mm. longa, 0.5 mm. crassa, deoperculata sub orificio contracta. Operculum conicum 0.6 mm. altum. Dentes peristomii 0.46 mm. longi, 0.067 mm. lati, pallide lutei, apicibus hyalinis, basi aurantiaci et leniter transverse striati. Sporæ 0.021—0.024 mm., papillulosæ.

S. Iceland: Flokastadagil, on stones at the margin of the river. The capsules were empty in the middle of July.

249. **Brachythecium populeum** (Hedw.) Br. eur.

Hypnum populeum Hedw.

S. Iceland: Vik (H. J.)!, fr.; Drángshlid!, fr.

Grew in both the above localities on rather dry tuff rocks.

250. **Brachythecium velutinum** (L.), Br. eur.

S. Iceland: Thingvellir (Gr.;!); Vik (H. J.)!; Holt!, in a cave at an altitude of about 300 metres, fr.

Near Thingvellir it grew in a lava-cleft, associated with *Blepharostoma trichophyllum*, *Plagiochila asplenioides* and *Plagiothecium silvaticum*.

251. **Brachythecium glaciale** Br. eur.

Hypnum glaciale C. Hartm.

N. Iceland: Akureyri!, at an altitude of 770 metres. NW. Iceland: Sugandafjörður!, at an altitude of 450 metres. W. Iceland: Dalasýsla, Melár, on a cliff inhabited by sea-fowl (H. J.)!.

On damp gravelly flats. Near Sugandafjörður it grew abundantly, intermixed with *Hypnum stramineum*, *Mniobryum albicans* and *Philonotis fontana*, in cushions 3—4 cm. deep, on ground saturated by melting snow, and on stones. The plants were about 5 cm. long and irregularly branched with unequally long — mostly short — branches. The leaves were erectly spreading, not secund, and very longly decurrent with numerous quadrate, thin-walled cells at the basal angles of the leaves.

252. **Brachythecium reflexum** (Starcke) Br. eur.

Commonly distributed.

This species has its main distribution in gravelly spots on the rocky flat, especially on slopes and dry snowless patches on the mountain heights. It is especially abundant in NW. Iceland, where it is everywhere the most frequently occurring species on stony slopes. Here it is usually found associated with *Hypnum uncinatum*, *Lescurea* spp., *Lophozia lycopodioides*, *L. Flörkei*, etc., and is met with as high as about 500 metres above sea-level. In Esja, in SW. Iceland, it was common from about 200 metres upwards. In the low land it is rarer and appears

to occur more particularly in the lava-fields, for instance near Hafnarfjörður. Thingvallahraun and Kihlbraun. It is found rather frequently in fruit.

253. **Brachythecium glareosum** (Bruch) Br. eur.

Hypnum glareosum Bruch.

E. Iceland: Seydisfjörður, on stones!. N. Iceland: Tverá in Öxnadalur, on damp gravelly ground!. W. Iceland: Botnsdalur, on damp rocks!.

254. **Brachythecium albicans** (Neck.) Br. eur.

- *Hypnum albicans* Neck.

Commonly distributed over the whole of Iceland.

This species grows on a dry substratum, for instance on sandy or grass-covered ground, on soil-covered stones, on dikes and on the peat-walls of houses. It is most frequent in the low land up to a height of about 300 metres, but occasionally, for instance near Akureyri, it ascends as high as about 600 metres above sea-level. Only sterile specimens have been found.

255. **Brachythecium erythrorrhizon** Br. eur.

Hypnum erythrorrhizon Hartm.

N. Iceland: Hof near Eyjafjörður (O. D.)!; Ljosavatn!; Tverá in Öxnadalur!. W. Iceland: Esja!.

Found in all the localities only scantily intermixed in the tufts of other mosses on rather dry ground. Near Ljosavatn it grew in the *Betula nana* heath in association with *Hylocomium proliferum*, *Hypnum uncinatum*, *Heterocladium squarrosulum* and *Lophozia lycopodioides*; in Esja it grew on a slope with a southern exposure, in company with *Hylocomium* spp. and *Hypnum imponens*.

256. **Brachythecium rivulare** (Bruch) Br. eur.

Hypnum rivulare Bruch.

Very common over the whole of Iceland.

One of the most frequent mosses, which occurs everywhere on damp ground up to about 400—500 metres above sea-level. It occurs both in large and small streams, where it covers the stones or the gravelly soil along the banks with its extensive mats, and in bogs, and is also one of the species which is most frequently met with in moss bogs. Occasionally, however, it grows also on a more dry substratum, for instance on soil-covered rocks and among grass. Only sterile specimens have been found.

257. **Brachythecium latifolium** (Lindb.) Philib.*Hypnum latifolium* Lindb.Gjá near Alptagerdi (St.)!, in company with *Mnium punctatum*.258. **Scleropodium purum** (L.) Limpr.*Hypnum purum* L.

SW. Iceland: Álafoss!. S. Iceland: Breidabolstadr!; Barkardstadr!; Holt!; Drángshlid!; Skógafoss!.

This species has been found only in the southern part of Iceland, where it is frequent on Fljótshlid and below Eyjafjall. Near Álafoss it grew on the slope stretching down towards the river in which the temperature of the water was about 25°. Usually it grows at the foot of cliffs with a southern exposure, or in clefts, and, as a rule, in association with *Hylocomium* spp., *Eurhynchium piliferum*, *Mnium undulatum*, *Thuidium delicatulum* and *T. tamariscinum*.

259. **Eurhynchium strigosum** (Hoffm.) Br. eur.*Hypnum strigosum* Hoffm.Var. *præcox* (Hedw.) Lindb.

N. Iceland: Hof (O. D.)!; Vidimýri (Gr.)!. W Iceland: Kalmanstunga (Gr.)!; Gilsbakki!; Reykjavík!. S. Iceland: Barkarstadr!.

Grows everywhere rather scantily on dry soil-covered rocks or on tuff.

260. **Eurhynchium diversifolium** (Schleich.) Br. eur.*Hypnum strigosum* var. *diversifolium* Lindb.

N. Iceland: Reykjahlid!; Hofsfjall near Eyjafjörður (O. D.)!; Akureyri, at an altitude of about 900 metres!.

Near Akureyri it grew in gravelly soil at the summit of the mountain, interspersed in tufts of *Sphærocephalus lurgidus*, *Dicranum congestum* and *Hylocomium proliferum*. Near Reykjahlid it grew intermixed in a tuft of *Timmia austriaca*.

Eurhynchium præcox and *E. diversifolium* are so closely allied that, according to my opinion, it is doubtful whether the last species can be regarded as anything more than a decidedly Alpine form of *Eurhynchium strigosum*. The leaves in the plants determined as *E. diversifolium* are longly decurrent. The cells of the basal angles of the leaves vary considerably in number, even on the same plant, usually they are very numerous; but specimens of *E. strigosum* var. *præcox* from Central Europe also vary considerably in this respect, and often have many more alar cells than has the type.

261. **Eurhynchium cirrosum** (Schwägr.) Limpr.*Brachythecium cirrosum* (Schwägr.) Schimp.

SW. Iceland: Esja!; Kolvidarhol!, at an altitude of about 300 metres.

In Esja it grew rather scantily on a damp slope, in company with *Hypnum chrysophyllum*. Near Kolvidarhol it grew abundantly on the ground among grass and species of *Carex*.

262. **Eurhynchium piliferum** (Schreb.) Br. eur.*Hypnum piliferum* Schreb.

W. Iceland: Budahraun (H. J.); Álafoss near Reykjavík!; Hafnarfjörður!. SE. Iceland: Hornafjörður!. S. Iceland: Reykirdalur!, up to about 150 metres above sea-level; Breidabolstadr!; Holt!, in several places up to about 300 metres above sea-level; between Thingvellir and Geysir (Gr!); common around Thingvellir!; Drángshlid!; Vestmannaey!.

Rather common in the South-western and Southern parts of Iceland. It usually grows in protected localities, for instance in lava-clefts, but occasionally, for instance near Reykir, it occurs on moss-grown slopes in company with *Hylocomium* spp. Near Thingvellir it was found abundantly in Almannagjá, at the grass-covered bottom of the ravine. Only sterile specimens have been found.

263. **Eurhynchium Swartzii** (Turn.) Curnow.*Hypnum Swartzii* Turn.

S. Iceland: Drángshlid (H. J.); Merkjáfoss (F.); common on Fljóts-hlid and below Eyjafjall!; Reykirfoss!. SW. Iceland: Álafoss.

This species was found only in S. Iceland, but was common there on damp rocks, especially at the base of the sides of tuff rocks in clefts and in damp caves. Only sterile specimens have been found.

Note. *Eurhynchium hians* from Merkjáfoss leg Feddersen belongs to *E. Swartzii*.

Hypnum praelongum is recorded from Iceland by Zoëga. There are no specimens of it in the collections, but perhaps it has been confused with *E. Swartzii*.

264. **Eurhynchium Stokesii** (Turn.) Br. eur.*Hypnum Stokesii* Turn.

S. Iceland: Drángshlid!; Hrutafell!; Holt!; Seljaland!; Vestmannaey (H. J.;!).

Rather common south of Eyjafjall and on Vestmannaey. It usually grows rather scantily on the ground, between blocks of rock or in clefts. On Vestmannaey it occurred in several places; among other localities at the foot of cliffs, in company with *Mnium undulatum* and *Lophocolea cuspidata*. Only sterile specimens have been found.

265. **Rhynchostegium murale** (Neck.) Br. eur.*Hypnum murale* Neck.

S. Iceland: Drángshlid!; Hrutafell!.

In the above localities it grew rather abundantly at the foot of dry tuff rocks and on fallen blocks. The fruit was ripe in the latter half of July, but some of the lids still persisted.

266. **Rhynchostegium rusciforme** (Neck.) Br. eur.*Hypnum rusciforme* Neck.

N. Iceland: Near Eyjafjörður (O. D.)!. NW. Iceland: Isafjörður!. W. Iceland: Dalsmýnne in Nordredalur!; Lundurreykjadalur!; Esja!; Ellidará near Reykjavík!. S. Iceland: Tungufoss (F.)!; Vik (H. J.)!; Reykirdalur!, fr.; frequent on Fljótshlid and near Eyjafjall!.

Var. *atlanticum* Brid.

N. Iceland: Between Svinadalur and Dettifoss!; Husavík!. W. Iceland: Esja!, in several places. S. Iceland: Reykirdalur!; Holt!; Vik (H. J.)!.

The type is rather frequent in the Southern and Western parts of Iceland, rarer in North Iceland, and has not been found in East Iceland. It usually grows on wet rocks near waterfalls, or on stones in the rivers, as a rule rather scantily, and mixed with *Brachythecium rivulare*, *Hypnum ochraceum*, etc. Only in Reykirdalur did it occur abundantly in the river and on the rock-sides by the waterfall, also in fruit.

Var. *atlanticum* is found in swiftly flowing rivers, where it often covers the bottom and stones for long distances.

267. **Thamnium alopecurum** (L.) Brid.

W. Iceland: Dalasýsla, Vogur (H. J.)!; Jærngerðarstaðr (Sæmundson)!. S. Iceland: Reykirdalur!; Paradishellir (Stp.)!; common on Fljótshlid and below Eyjafjall!.

On wet shady rock-faces and in caves. In S. Iceland it is common in the tuff-clefts, especially on the inwardly sloping surfaces, and in the numerous dark, damp caves, where it often covers the roof and sides through which water is percolating. Only sterile specimens have been found.

268. **Plagiothecium silvaticum** (Huds.) Br. eur.

N. Iceland: Grimsey (O. D.)!. S. Iceland: Thingvellir (Gr!.)!; Almagnagjá!.

In Almagnagjá it was found scantily at the bottom of a lava-cleft. Only sterile specimens were found.

269. **Plagiothecium Roeseanum** (Hampe) Br. eur.Syn. *Plagiothecium silvaticum* var. *Roesei* (Hampe) Lindb.

Commonly distributed, but as a rule rather scantily, in soil-filled rock-crevices, in company with *Mnium orthorrhynchum*, *Plagiochila*

asplenioides, *Pohlia cruda*, etc., up to about 300 metres above sea-level. Near Kolvidarhol and Seljaland it was found at an altitude of about 400 metres. Only sterile specimens have been found.

270. *Plagiothecium denticulatum* (L.) Br. eur.

N. Iceland: Mývatn (Gr.;!); Grimsey (O. D.); Hof (O. D.); Vidvík (P. Sólóniasson); Ásbýrgi!. NW. Iceland: Grunnavík!; Kaldalon!. W. Iceland: Gilsbakki!; Hafnarfjörður!; Reykjavík!. S. Iceland: Thingvellir!; Holt!; Vestmannaey!.

Found here and there on humus-covered rocks or in lava-clefts, but everywhere scantily only, and sterile.

Recorded by König and Steenstrup from Iceland, but there are no specimens of it in the collections.

Plagiothecium undulatum is recorded by Lindsay and *P. silesiacum* by Hornemann (from Geysir), but no specimens of either of these two species are to be found in the collections, so the determinations are undoubtedly erroneous.

271. *Plagiothecium pulchellum* (Dicks.) Br. eur.

Isopterygium nitidum v. *pulchellum* Lindb.

Iceland (Mörch). Commonly distributed over the whole of Iceland.

Grows in rock-crevices, caves, lava-clefts, etc.; either in small unmixed tufts or, more often, intermixed with other mosses. It does not appear to ascend higher than about 400 metres above sea-level and, as a rule, sets fruit.

The majority of the plants which have been investigated belong to the type. Var. *nitidulum* Wahlb. L. et J. (*Isopterygium nitidulum* Lindb.) is far rarer, and grows by preference especially in deep shade; but, for the rest, this form is not very characteristic and passes without limit into the type.

272. *Plagiothecium depressum* (Bruch) Dixon.

S. Iceland: Holt!; Vestmannaey, Heljúsadalur!.

In Heljúsadalur it grew in masses on a talus of fallen blocks and debris (Úrd), everywhere covering the ground between the large blocks with its brightly shining mats. Near Holt it was found mixed with *Brachythecium velutinum* at the bottom of a tuff cave at an altitude of about 300 metres.

273. *Plagiothecium elegans* (Hook.) Sull.

Isopterygium elegans (Hook.) Lindb.

S. Iceland: Reykirdalur!, at an altitude of 260 metres.

It was growing here on warm soil in the neighbourhood of a sulphur spring, on the ground below a projecting block of rock, in company with *Diplopyllum albicans* and *Pellia Neesiana*.

The form found is robust, light green, highly shining and differs in habit by the leaves being very decidedly two-rowed, spreading. Gemmæ, which were, by the by, quite typical, occurred only extremely few in number.

274. **Amblystegium Sprucei** (Bruch) Br. eur.

Commonly distributed over the whole of Iceland.

Grows in rock-clefts, dark ravines and caves, and among fallen blocks of rock, usually scantily woven into the tufts of other mosses such as *Plagiolthecium pulchellum*, *Amphidium Mougeottii*, *Lophozia Mülleri*, *L. heterocolpos* and *Mnium orthorrhynchum*, but occasionally also in tiny cushions or as delicate, cobweb-like coverings on roofs in caves. In Esja it was found up to about 400 metres above sea-level. Only sterile specimens have been found.

275. **Amblystegium fluviatile** (Sw.) Br. eur.

SW. Iceland: Tungufoss (F.)!, determined by C. Jensen.

Only a few stems were found, intermixed with other mosses, for instance *Brachythecium rivulare*, *Hypnum ochraceum*, etc.

276. **Amblystegium serpens** (L.) Br. eur.

N. Iceland: Akureyri, fr. (Gr.)!; Mývatn, fr. (Gr.)!. W. Iceland: Reykjavík!. Vestmannaey!, fr.

In Iceland this species is as variable as it is in other places. The specimens from Mývatn were very robust, with leaves 1.33 mm. long and 0.65 mm. broad, erectly spreading, and distinctly toothed in their lower half, with rather long and strong nerve, and cells 0.010—0.012 mm. broad and 4—6 times as long. Near Reykjavík it grew in large cushions, 1—2 cm. deep, on a stone wall near the sea-side. In the plant from the latter locality the leaves were broadly ovate, longly pointed and almost entire at the margin, with cells 0.009—0.011 mm. broad and 2—3 times as long. The form from Vestmannaey is very slender, with leaves 0.7 mm. long and 0.3 mm. broad, with very short nerve which in the branch leaves was just indicated immediately above the leaf-base. On Vestmannaey the fruit was quite unripe on July 6th; in N. Iceland it was ripe at the end of July.

277. *Subsp. **Amblystegium Juratzkanum** Schimp.

N. Iceland: Fagriskogur (St.)!. S. Iceland: Drángshlid!, fr.; Vestmannaey!.

The plant from Drángshlid was quite typical and bore ripe capsules at the end of July. The specimens which were collected on the base of a birch-trunk in Fagriskogur agreed fairly well with the form described by Limpricht (*Kryptogamenflora*, vol. III, p. 323) under the name of *Amblystegium radicale*. The leaves taper from an ovate-lanceolate base

to a very long and slender point, and are about 1 mm. long and 0.4 mm. broad. The branch leaves are lanceolate and toothed along their entire margin, with short nerve. The cells at the base of the leaf are quadrate, yellow and rather thick-walled, 0.012–0.015 mm. broad; those in the upper half of the leaf narrowly prosenchymatous, 0.08 mm. broad, and 6–8 times as long, and often somewhat wavy.

278. Subsp. * **Amblystegium littorale** (C. Jens.) Hesselbo.

Syn. *Amblystegium serpens* var. *littoralis* C. Jens. in "Færøernes Mosser".

N. Iceland: Grimsey (O. D.)!. W. Iceland: Reykjavik!; Brjanslækur (H. J.)!.

Both the plants agreed exactly with the specimens collected by C. Jensen in the Færøes. *A. littorale*, which is a Sub-arctic-Arctic form, is probably widely distributed. It has been found not only in the Færøes and in Iceland but also on Jan Mayen (Dusén) and in Sweden, on Gislö near Troså (Arnell). It has as yet been found sterile only.

279. **Amblystegium compactum** (C. M.) Br. eur.

Vestmannaey (H. J.;!). SW. Iceland: Öndverðarnes, in a well together with *Trentepohlia aurea* (H. J.)!.

On Vestmannaey this species occurred rather frequently on the sides of clefts and caves in tuff rocks. It grew there in company with *Trentepohlia*, especially in places where water was percolating through, and occurred sometimes in compact cushions several cm. deep, sometimes as a thin covering. The Iceland specimens agree exactly with North American plants of *A. compactum*; occasionally, however, the leaves especially of the forms growing as thin coverings are somewhat broader, with shorter cells.

W. Mönkemeyer and L. Loeske (Revision einiger *Amblystegien* aus dem Herbare Limpricht; Ungarischen bot. Blätter, 1911, p. 273) refer *Amblystegium salinum* Bryhn to *A. compactum* as var. *salinum* (Bryhn Mkm. On investigating numerous specimens of *A. salinum* I have, however, arrived at the conclusion that these two species are in no way connected with each other. *Amblystegium compactum* forms compact, dark-green tufts with a somewhat silky lustre, closely interwoven in the interior with rusty brown rhizomes which proceed partly from the stem and partly, in very great numbers, from the under side of the stem-leaves. The stem is prostrate with apex rising upward, and with numerous branches. The leaves are very close-set, longly decurrent, erectly spreading and secund. The stem leaves taper from a broadly ovate base to a long and slender point with strongly curved back apex. The branch leaves are narrowly lanceolate, often with apex curved. The leaf-margin is sharply toothed along its entire length, and especially the lowermost teeth are often turned outwards or towards the base. In the branch leaves the nerve reaches to the apex and is of almost equal width along its entire length, straight, or sometimes slightly sinuous. The leaf-cells are narrower than in any other *Amblystegium*, 0.005—

0.006 mm. broad, and 6–10 times as long, thin-walled, pointed and wavy. On the whole, both the cell-tissue of the leaf and the form of the leaf-teeth call to mind far more an *Eurhynchium* or a *Rhynchostegium* than an *Amblystegium*.

Amblystegium salinum Bryhn grows in loose, yellowish green, hardly tomentose tufts. Rhizoids occur only on the lowermost part of the stem and scantily on the back of the nerve. The stems are erect or ascending, slightly and irregularly branched. The leaves are far more distant than in *A. compactum*, are spread out almost horizontally, very longly decurrent, ovate-lanceolate, with long, often somewhat obtuse apex; all are similar or the branch leaves are somewhat narrower. The leaf-margin is finely and obtusely toothed till towards the apex. The leaf-cells have the appearance typical of *Amblystegium*, and in the upper half of the leaf are 0.008 mm. broad and 4–6 times as long, with sinuose primordial utricle (the latter is usually wanting in *A. compactum*). The nerve is green and sinuose (as in *A. varium*) and vanishes just below, or in, the leaf-apex itself. *A. salinum* is undoubtedly a true *Eu-Amblystegium* which is nearest allied to *A. serpens*, but also approaches certain forms of *A. varium* (Hedw.) as regards the form of the basal cells of the leaf and the long sinuous nerve. It would also be remarkable if a species like *A. compactum*, which in North America grows on rocks and on damp ground in woods in the interior of the country, should in Europe turn into a decidedly salt-soil plant. *A. salinum* has been collected in many places along the coasts of Sweden and Norway; first by Zetterstedt on Öland and near Bosekop in Finmarken, and in the herbarium is named by him *Amblystegium serpens* var. *littorale*. Hagen has collected the same species in Salten in Nordland (65° 15' N. lat.), where it was growing in company with *A. littorale* (C. J.), and in a letter he named it *Amblystegium breve* n. sp. On the other hand, it is not known to me that the real *A. compactum* has been collected in Scandinavia. I have not seen the *A. compactum* from salty soil in North Germany mentioned by Loeske (loc. cit. pp. 272–273), nor have I seen Mönkemeyer's *A. compactum* from Bornholm.

280. *Amblystegium salinum* Bryhn.

Vestmanhaey! on damp sandy soil near the coast, sterile.

281. *Amblystegium trichopodium* (Schultz) Br. eur.

N. Iceland: Grimsey (O. D.)!

Judging from the plentiful intermixture of Green Algæ, the plants from the above locality must have been growing on wet, probably muddy ground. ♂ and ♀ flowers were present in great numbers; fruit, on the other hand, had not been developed. The stem leaves were rather close-set, horizontally out-spreading, from an ovate base tapering to a long and slender point, finely toothed along the entire margin, 1.2–1.5 mm. long and 0.50–0.55 mm. broad, with green nerve, 0.04–0.045 mm. wide. The branch leaves were lanceolate, 0.95 mm. long and 0.30–0.35 mm. broad, with short green nerve. At the base of the leaf the cells were

green and rectangular, 0.018 mm. broad and 0.070 mm. long, in its upper half, 0.010 mm. broad and 4—7 times as long, with sinuous primordial utricle.



Fig. 17. *Amblystegium trichopodium* (Schultz). Habit ($\times 3$).



Fig. 18. *Amblystegium trichopodium* (Schultz) Br. eur. *a*, Stem-leaves and *b*, branch-leaves ($\times 20$); *c*, leaf-cells near margin ($\times 120$).

282. **Hypnum Sommerfeltii** Myrin.

N. Iceland: Stora Brekka near Eyjafjörður (O. D.)!. S. Iceland: Fell (Harder, 1908)!, a few stems among *Hypnum uncinatum*, *H. stellatum* and *Dilrichum flexicaule*.

283. **Hypnum chrysophyllum** Brid.

Amblystegium chrysophyllum (Brid.) Lindb.

E. Iceland: Berufjörður!. N. Iceland: Near Mývatn (Grl.)!; Hof near Eyjafjörður (O. D.)!. W. Iceland: Esja, several places (Grl.;!). S. Iceland: Geysir, on warm ground!. Vestmannaey, HeljUSDalur!.

Var. *β tenellum* Schimp.

W. Iceland: Esja!.

On damp gravelly ground and on rocks, rather rare and scanty. Near Geysir it grew plentifully on warm damp ground over which the tepid water from the basin was flowing. Only sterile specimens have been found.

Hypnum Zemlae C. Jensen, which was collected by Steenstrup (but no habitat is given) is only a form of *Hypnum chrysophyllum*.

284. **Hypnum protensum** Brid.

Amblystegium protensum Lindb.

E. Iceland: Skreiddalur!; Seydisfjörður!. N. Iceland: Hof (O. D.)!; frequent in Esja!.

This species is probably widely distributed, but, on account of its great resemblance to the far more commonly occurring *H. stellatum*, cannot always be kept distinct from the latter species. It grows in somewhat damp localities, both on stones and on the ground, but only sterile specimens have been found.

285. **Hypnum stellatum** Schreb.

Amblystegium stellatum (Schreb.) Lindb.

Very common everywhere on a damp substratum, on rocks, on the ground and in bogs, and not rarely in fruit. It is abundant even at a height of 500—600 metres above sea-level.

286. **Hypnum polygamum** (Br. eur.) Wils.

Amblystegium polygamum Br. eur.

Very common on wet, boggy ground. It occurs especially abundantly in the neighbourhood of the coasts, but is also very common in the valleys further inland, and hardly ascends higher than about 300 metres. Fruit, which is met with very frequently, ripens at the end of June or in the beginning of July.

287. **Hypnum intermedium** Lindb.*Amblystegium intermedium* Lindb.

This species is no doubt common, at least in N. Iceland, where it occurs around Eyjafjörður up to about 500—600 metres above sea-level. Only sterile specimens have been found.

288. **Hypnum revolvens** Sw.*Amblystegium revolvens* De Not.

Very common over the whole of Iceland.

One of the most frequent and abundantly occurring mosses, which often forms the bulk of the vegetation in the bogs, both in the low land and in the Alpine region where it is plentiful even at an altitude of about 600 metres, for instance near Eyjafjörður. Fruit, which is often present abundantly, ripens in the beginning of July.

Hypnum revolvens is distinguished from *H. intermedium* only by the fact of its being monoicous. Therefore, in cases of the frequently occurring quite sterile plants, it is really impossible to decide whether they belong to the one or to the other species. This is especially true of the vigorous, slightly branched aquatic forms, which had previously been referred to *Hypnum Cossoni* Schimp. Both *H. revolvens* and *H. intermedium* form such *Cossoni*-forms, but as they are mostly quite sterile it is impossible to determine them with any certainty.

289. **Hypnum uncinatum** Hedw.*Amblystegium aduncum* (L.) Lindb.

Very common everywhere upwards to the limit of plant-growth.

Var. *orthothecioides* (Lindb.).

N. Iceland: Grimsey (O. D.)! NW. Iceland: Arngardareyri! Grunnavik! E. Iceland: Kirkjuból (H. J.)!

Hypnum uncinatum is one of the most common mosses and occurs everywhere both on dry and on damp substrata, on earth, on rocks, in bogs, etc.; and often in such quantities that it is the most abundant constituent of the moss-carpet. It varies exceedingly in size, habit and colour. *Hypnum orthothecioides* cannot be maintained as species; in addition to the forms found in the above-mentioned habitats, others forming all possible transitions to the type have been found in many other localities. Fruit, which is rather common, ripens in the first half of July.

290. **Hypnum Sendtneri** Schimp.*Amblystegium Sendtneri* (Schimp.) De Not.

N. Iceland: Helgavatnsfloi (Stp.)!

291. **Hypnum Kneiffii** (Br. eur.) Schimp.*Amblystegium Kneiffii* Br. eur.

This species is common, especially in N. and E. Iceland, and is somewhat rarer in NW. and S. Iceland. It grows in very wet situations in bogs, in pools, along the banks of rivers or covering stones in the water.

Aquatic forms with slightly secund, longly pointed leaves are frequent; short and broad leaved orthophyllous or drepanophyllous forms occur more rarely. The size of the leaf-cells is dependent on the form of the leaf; in *f. brevifolia* they are short in the middle of the leaf, about 3—4 times as long as they are broad. In Esja a brevi-orthophyllous form was collected in a moss-bog at an altitude of 410 metres.

It has been collected in fruit only near Husavik in N. Iceland.

292. **Hypnum exannulatum** (Gümb.) Br. eur.*Amblystegium exannulatum* De Not.

Very common.

Hypnum exannulatum occurs in numerous forms everywhere on a damp substratum, often forming the bulk of the vegetation, either alone or mixed with other *Hypnaceae* (*H. stramineum*, *H. revolvens*, etc.), with *Cinclidium*, *Mnium* spp., and other bog mosses. It grows not only in bogs, but also in pools, moss-bogs, along streams, and occasionally on damp rocks. Near Akureyri it was abundant even at an altitude of 600 metres.

Var. *purpurascens* (Schimp.) (*Hypnum purpurascens* Limpr.) is the most frequent form, at any rate in N. and E. Iceland. It is usually purplish, more rarely green, erect, as much as about 20 cm. high, and often forms large, pure growths on very wet ground, especially in the water itself, for instance along the banks of small streams. In this form the leaf-base is never decurrent. In the plants which have been investigated the cells of the leaf-base are sometimes quite typical, forming a single row of large dilated cells across the entire leaf-base, and sometimes they approach those of the type by forming a more or less large, triangular group of empty cells towards the leaf-margin. In typical *Hypnum exannulatum* the leaves are always narrowly decurrent.

Var. *Rotæ* (De Not.) is without doubt an extreme aquatic form of var. *purpurascens*, with which it is closely connected by intermediate forms. It has the solid, tough stem with long, forwardly directed branches and very narrow, slightly secund leaves peculiar to all mosses growing in swiftly flowing water. The nerve is very strong, usually 0.10 mm. wide at the base and, as a rule, vanishing in the apex, more rarely excurrent. It grows in running water, often in streams flowing through boggy ground. Typical specimens were collected in the following localities: E. Iceland: Seydisfjörður!, rather common; Breiddalskard!; Fróðarheiði (H. J.)!. NW. Iceland: Kaldalon!; Dýnjandi!. W. Iceland: Hvammur (Gr.)!; Esja!, at an altitude of 100 metres. Only sterile specimens have been found.

Var. *serratus* (Warnst.).

Isafjörður!, in pools.

In *H. exannulatum* the length of the leaf-cells varies according to the shape of the leaf. In the most commonly occurring forms with longly pointed leaves the cells are narrow, 6—10 times as long as broad, while short-leaved forms have leaf-cells which are only 4—6 times as long as broad (var. *brachydictyon* (Ren.)), such forms are especially met with on cold, wet gravelly ground. Fruit is rather frequent, both in the type and in var. *purpurascens*, and ripens at the end of July.

293. *Hypnum fluitans* (Dill.) L.

Amblystegium fluitans (L.) De Not.

S. Iceland: Breidabolstadr (F.)!; Breidamerkursandur (Harder)!.

N. Iceland: Bleikjuholt (St.)!; Mývatn (Gr.)!.

Monoicous forms, which may be referred to *H. fluitans* occur only very scantily and rarely in Iceland. The numerous older records of the occurrence of this species (Vahl, Mörch, Hornemann, Grönlund, etc.) are, without exception, due to erroneous determinations, and all the older specimens in the collections (except one) belong to *H. exannulatum* or *H. Kneiffii*.

H. fluitans grows everywhere in pools or on inundated ground. Near Bleikjuholt Stefánsson has collected a very peculiar form, with erect, obtuse leaves with short nerve. The cell-tissue of the leaves is very loose, and the cells of the leaf-base differ only slightly from the other cells.

Var. *falcatum* Schimp. (*Hypnum* *H. Schultzii* Limpr.)

This very characteristic form was found abundantly, and in fruit, on wet boggy ground near Kaldalon in NW. Iceland.

294. *Hypnum filicinum* L.

Amblystegium filicinum (L.) De Not.

Very common.

In the greater part of Iceland this species is one of the most frequent mosses on a damp substratum, especially on wet rocks, but also on gravelly ground and in bogs. In most part of N. Iceland it is somewhat rarer, and usually occurs more scantily. In S. Iceland it often covers the faces of wet tuff-rocks in enormous mats and not rarely sets a great quantity of fruit. In the rest of Iceland fruit is rarer and occurs most often in the large, tomentose bog-form. In S. Iceland fruit was ripe in the middle of July.

Hypnum filicinum varies exceedingly. Bog forms and forms from wet gravelly ground are usually densely tomentose and regularly pinnately branched. Rock forms, when growing on a more dry substratum, are slender and slightly branched: on wet rocks, especially on tuff, very large and vigorous, often almost like *Hypnum commutatum*.

H. filicinum has its main distribution in the lowlands up to about 300 metres above sea-level, but is also frequently met with, for instance near Berufjörður and in Esja, up to a height of about 500 metres. At this altitude it grows on rocks in low, dense cushions, more rarely on wet gravelly ground, and these Alpine forms constitute a distinct transition to *H. curvicaule* Jur., which is perhaps only a High Alpine form of *H. filicinum*.

295. *Hypnum curvicaule* Jur.

Amblystegium curvicaule (Jur.) Dicks. & James.

E. Iceland: Berufjardarskard!, 540 metres above sea-level; Seydisfjörður!, frequent from about 100–500 metres above sea-level. W. Iceland: Möðruvellir!, about 400 metres above sea-level.

Grows on damp gravelly ground and rocks on mountain heights up to 500–600 metres. On dry rocks the leaf-cells become longer and narrower and the alar cells more thick-walled. Near Seydisfjörður it was collected with quite young fruit (3. 7. 1909).

296. *Hypnum decipiens* (De Not.) Limpr.

Amblystegium glaucum *β. decipiens* Lindb.

E. Iceland: Very common near Seydisfjörður!; Dvergasteinn (H. J.)! N. Iceland: Husavik!; Ljosavatn!; Akureyri!; Öxnadalur!. W. Iceland: Brattabrekka!.

Common from Seydisfjörður in E. Iceland throughout the whole of N. Iceland. The westernmost habitat of this species is Brattabrekka, south of Haukadalur. In the rest of Iceland it has not been observed.

Hypnum decipiens grows on very wet, especially gravelly, ground, for instance at the edge of moss-bogs or on inundated gravelly ground, and along small streams both on the ground and on stones. It hardly ascends higher than about 300 metres, and rarely sets fruit. Near Seydisfjörður, Husavik and Tverá in Öxnadalur it was collected in fruit.

297. *Hypnum commutatum* Hedw.

Amblystegium glaucum (Lam.) Lindb.

E. Iceland: Seydisfjörður (H. J.)!. N. Iceland: Husavik!; Reykjavík!. W. Iceland: Lundur!; rather frequent in Esja!. S. Iceland: Rather common!.

Var. *falcatum* (Brid.) C. M. *Hypnum falcatum* Brid.

Very common.

H. commutatum is the more rarely occurring form. It is most frequent in SW. and S. Iceland, where it is especially abundant on wet tuff-rocks. It is rather rare and scanty everywhere else in Iceland.

Var. *falcatum*, together with all possible transitions to the type, is one of the most common mosses in the greater part of Iceland. Only in NW. Iceland is it scanty and met with only here and there. Both

forms grow on rocks in and by the water, on wet rock-faces and on the ground, both on wet gravelly ground and on the ground in bogs. It often forms, especially in N. Iceland, an essential part of the moss-carpet in bogs. It hardly ascends higher than about 300 metres above sea-level. ♀ plants are very common, ♂ plants and fruit are far rarer. It has been found in fruit near Stafafell, Seydisfjörður, Hrutafjörður and, rather frequently, in S. Iceland (both forms).

298. *Hypnum molluscum* Hedw.

Ctenidium molluscum (Hedw.) Schimp.

Iceland (Mörch)!: Bardshellir (Grl.)!: Brynjúdalur (Grl.)!. W. Iceland: Common near the hot springs in Reykholtalur!: Botnsdalur!: common about Reykjavík!: common in Esja!: Kolvidarhol!, up to about 350 metres above sea-level. S. Iceland: Very common!. SE. Iceland: Hornafjörður!.

This species is very common in S. Iceland, especially on Fljótshlíð and about Eyjafjall, but is also plentiful near Thingvellir, and frequent in SW. Iceland as far as Borgarfjörður, where it is, however, chiefly confined to the warm ground. It appears to be quite absent from the other parts of Iceland.

H. molluscum grows on a damp substratum, both on damp rocks, especially tuff, and on damp ground. Near Thingvellir it grew abundantly, covering the blocks at the bottom of the large lava-clefts. Around the hot springs in SW. and W. Iceland it occurs abundantly in several places. Thus in Reykholtalur it is one of the most frequent species of the warm clayey flats.

It occurs almost exclusively in the low land, and only near Kolvidarhol was it found about 350 metres above sea-level. Only sterile specimens have been found.

299. *Hypnum imponens* Hedw.

Stereodon imponens (Hedw.) Brid.

E. Iceland: Hof, on basalt rocks!. W. Iceland: Esja!: Braudarholt!. N. Iceland: Vidímýri, near a hot spring (Grl.)!. W. and SW. Iceland: Near almost all the hot springs!.

In SW. and W. Iceland it grew with a few exceptions on warm ground. In Esja it grew in company with *Camptothecium lutescens* on a grass-covered slope, and near Braudarholt intermixed with other *Hynaceæ* on the top of knolls in bogs.

On a warm substratum *Hypnum imponens* grows especially on the drier clay-flats: there it often forms extensive mats, partly alone, partly mixed with *Hypnum stramineum*, *H. Lindbergii*, *H. molluscum*, *Hylocomium squarrosum* and other species. Only sterile specimens have been found.

300. *Hypnum Bambergeri* Schimp.*Stereodon Bambergeri* (Schimp.) Lindb.

W. Iceland: Breidabolstadr in Reykholtadalur!.

It was growing there on a damp gravelly flat in company with *Ditrichum flexicaule*, *Myurella julacea*, *Tortella tortuosa* and *T. fragilis*.301. *Hypnum revolutum* (Mitt.) Lindb.*Stereodon revolutus* Mitten.

Very common over the whole of Iceland.

It grows both on dry and on more or less damp rocks, occasionally also on gravelly soil, and is frequent up to about 600—700 metres above sea-level. It varies considerably in size, from quite slender forms (for instance on lava blocks) to very robust forms on damp stones in clefts. Fruit, which was ripe in the middle of July (but the lids still persisted), was found only near Breidabolstadr in S. Iceland, where *Hypnum revolutum* grew in deep cushions, covering stones in a cleft.302. *Hypnum cupressiforme* L.

E. Iceland: Berufjörður (Grl.;!); Hof!; Hornafjörður!. N. Iceland: Víðvík near Skagafjörður (P. Söfóniasson)!; Víðimýri!; common west of Blóndudalur!. W. Iceland: Stykkisholmur!; Botnsdalur!; common about Esja, Hvalfjörður, Reykjavík and Hafnarfjörður!. S. Iceland: Common!. Vestmannaey!.

Common from Berufjörður in E. Iceland throughout S. and W. Iceland and the western part of N. Iceland to Blóndudalur. In E. Iceland it has not been found further northwards than Berufjörður, and in NW. Iceland it has not yet been observed. East of Hunaflói it has been found only in a few localities near Skagafjörður.

It usually grows on rather dry rocks or on soil-covered rock-ledges, and does not appear to ascend higher than about 300 metres above sea-level. Only sterile specimens have been found.

Var. *ericetorum* is recorded from Ormarstadir in E. Iceland (leg. H. J., det. C. Jensen), but there are no specimens of it in the collections.303. *Hypnum hamulosum* Br. eur.*Stereodon hamulosus* Lindb.

E. Iceland: Hof!, at an altitude of 100 metres; Hornafjörður!. W. Iceland: Esja, Möðruvellir!, on tuff rocks, 250—400 metres above sea-level; Kolvidarhol!; common on tuff, from 250 to 450 metres. NW. Iceland: Grunnavík!, at an altitude of about 280 metres. S. Iceland: Holt!; Drangshlid!. Vestmannaey!.

Rather frequent in the South-western and South-eastern parts of Iceland. It has been found almost everywhere on tuff-rocks, where it

occurred abundantly in several places, for instance in Esja, but only sterile specimens were found.

304. *Hypnum callichroum* (Brid.) Br. eur.

Stereodon callichrous Brid.

E. Iceland: Seydisfjörður!. NW. Iceland: Common everywhere!. W. Iceland: Budahraun (H. J.)!; Grundarfjörður (H. J.)!; common everywhere in the lava-fields east of Reykjavík and around Hafnarfjörður!; Svinahraun!; Esja, in *Grimmia*-heath at an altitude of about 400 metres, and in many places along the banks of streams!. S. Iceland: Skálholt!; Thingvellir!; Holt!, common on tuff-slopes in clefts.

This species is common in the south-western part of Iceland, and very common in North-west Iceland. In North Iceland it has not been found, and in East Iceland only near Seydisfjörður. It occurs in Iceland in two forms. The most frequent form is the typical bog-soil form, which is exceedingly common especially in NW. Iceland, and sometimes forms the bulk of the vegetation in damp situations, especially along streams, on wet slopes and at the edge of bogs, usually in association with *Harpanthus*, *Lophozia quinquedentata*, *Cephalozia bicuspidata*, etc. Around Isafjörður it occurs up to a height of about 300 metres, and in S. and SW. Iceland up to almost 500 metres above sea-level.

Everywhere in the depressions and at the bottom of the clefts of the lava-fields of South-western and West Iceland a mesophilous form is found, which is distinguished by its size and by its almost regularly two-rowed ramification. It grows in deep, loose and soft cushions, either among grass or mixed with *Hylocomium* spp., *Rhacomitrium hypnoides* and species of *Dicranum* and of *Lophozia*.

Fruit was collected only in Kaldalon in NW. Iceland; it was quite undeveloped even at the end of June.

305. *Hypnum Lindbergii* Mitten.

Stereodon arcuatus Lindb.

Very common.

This species grows on wet ground, especially in bogs, associated with *H. revolvens*, *H. cuspidatum*, *Hylocomium squarrosum*, *Meesa*, etc.; but also on damp gravelly ground and on soil-covered rocks. It appears to be of almost equal frequency everywhere. Near Berufjörður it was collected up to a height of about 500 metres above sea-level, and on Eyjafjall in S. Iceland it was frequent at the same height. Near Akureyri it occurred abundantly on boggy ground even at an altitude of 500-600 metres. Only sterile specimens have been found.

Hypnum pratense is recorded by Grönlund from several localities, but the record is due to a confusion with *H. Lindbergii*.

Note. *Hypnum incurvatum* is recorded from Iceland by Mörch, but the specimens in his collection belong to *Plagiothecium pulchellum*.

306. **Hypnum palustre** Huds.*Amblystegium palustre* (Huds.) Lindb.

E. Iceland: Seydisfjörður!. N. Iceland: Akureyri (Gr!.)!; Vidimýri (Gr!.)!; Grímstunga (Gr!.)!; Ljosavatn!, at an altitude of about 300 metres; Melar (Gr!.)!. W. Iceland: Gilsbakki!; Reykholtalur (Gr!.)!; Lundur-reykjadalur!; Reykjavík!: common in Esja!; Álafoss!. S. Iceland: Common!.

This species is common in S. Iceland (Eyjafjall, Fljótshlid, etc.), SW. and W. Iceland, is found here and there in N. Iceland and is rare in E. Iceland. It has not yet been found in NW. Iceland. It grows everywhere on rocks and stones in and by rivers, and almost always sets fruit, which ripens during July. It does not appear to ascend higher than about 300 metres above sea-level.

Of the varieties only var. *δ subsphaericarpon* (Schleich.) Br. eur. is of any interest. It occasionally occurs in company with the type on stones in swiftly flowing rivers.

307. **Hypnum arcticum** Sommerf.*Amblystegium Smithii* (Sw.) Lindb.

W. Iceland: Hvammur (Gr!.)!. NW. Iceland: Bæir! fr. It is, moreover, recorded from Iceland by Mörch and from Akureyri (Gr!.), but both the plants are wrongly determined.

Near Bæir it grew on wet rocks by a small waterfall.

308. **Hypnum alpestre** Sw.*Amblystegium rivulare* (Sw.) Lindb.

E. Iceland: Berufjörður!, common; Seydisfjörður!, common up to about 200—300 metres above sea-level; Breiddalskard!, at an altitude of about 400 metres; Vallanes (H. J.;!)!, common on rocks along the sea; Skriddalur!. N. Iceland: Öxnadalur!, very common in the river. NW. Iceland: Isafjörður!, frequent up to about 200 metres; Sugandafjörður!; Arngerdareyri!. W. Iceland: Lundur!. SW. Iceland: The Laxá (F.)!; the Langá (H. J.)!; the Öxarará!.

Common in E., N. and NW. Iceland, rarer in W. and SW. Iceland. This species has its main distribution in E. Iceland, where it occurs everywhere in the rivers and often covers the stones along the banks for long distances. Fruit, which occurs rather commonly, ripens in July (Öxnadalur, July 24; Vallanes, hardly ripe on June 28th).

309. **Hypnum alpinum** Schimp.*Amblystegium molle β alpinum* Lindb.

E. Iceland: Berufjörður!. N. Iceland: Akureyri (Gr!.;!)!; Hof near Eyjafjörður (O. D.)!; Holar (Gr!.)! fr.; Lækjarmot! fr.; common in Öxnadalur! fr., NW. Iceland: Isafjörður! fr.; Dýrafjörður! fr.; Arngardareyri! fr.; Dýnjandi! fr.

Figured in Flora Dan. (tab. 2621, fig. 2) as *Hypnum molle*, leg Mörch.

This specimen is not to be found in the collections: on the other hand, a specimen from Iceland, determined by Mörch as *Hypnum arcticum*, belongs to *H. alpinum*.

Rather common in N. and NW. Iceland, where it grows on stones in rivers, like the other species of *Hygrohypnum*. It does not ascend higher than about 200 metres above sea-level (Ísafjörður), and often sets fruit which ripens in N. Iceland in the latter half of July.

Hypnum alpinum varies considerably in leaf-form, leaf-tissue and habit.

The leaves, which are most often spreading, are occasionally falcato-secund along the entire length of the stem, in which feature it approaches *H. dilatatum* in habit. The Iceland specimens of *H. alpinum* approach, on the whole, *H. dilatatum*, both in habit, leaf form and structure of cell-tissue. The cells of the base of the leaves are often thickened and slightly porous, and the alar cells are sometimes colourless and thin-walled, sometimes yellowish with slightly thickened walls. The leaf-form varies from almost orbicular to elliptic. The leaf-margin is almost always finely toothed all round.

I have, however, thought it more correct to refer all the Iceland plants to *H. alpinum*, as at any rate the capsule and the perichæcium corresponded exactly to those in this species. Thus, fully developed cilia have never been found in the peristome. The leaf-cells are also shorter than in *H. dilatatum* and in size agree most nearly with those in *H. alpinum*.

310. *Hypnum ochraceum* Turn.

Amblystegium ochraceum Lindb.

Very common on stones in rivers up to 300–400 metres above sea-level, but only sterile specimens have been found.

Varies considerably in size, habit, etc.

Var. *uncinatum* Milde often occurs in company with the type.

Var. *filiforme* Limpr. is rather common in swiftly flowing rivers, where it often covers the bottom for long distances.

Note. *Amblystegium polare* Lindb. is recorded by Grönlund (Tillæg til Islands Kryptogamflora, Bot. Tids., 20, p. 113 to have been collected near Vallanes by H. Jónsson. The specimen in question is in the Botanical Museum in Copenhagen and is labelled "*Dichodontium pellucidum*, *Polytrichum alpinum*, *Amblystegium polare*, det. C. Jensen", but in spite of a careful search it was not possible to find *A. polare* among the specimens, so for the present the occurrence of this species in Iceland must be regarded as uncertain.

311. *Hypnum cordifolium* Hedw.

Amblystegium cordifolium De Not.

N. Iceland: Mývatn (Grí.)! NW. Iceland: Grunnavík!, fr.

This species is also recorded from the Ölfusá, Nesland, Litlu Borgarkatlar and Thorodstadaengjar, but the plants from all these localities

are only forms of *H. giganteum*, which often occurs in slender, slightly branched forms, which are very difficult to distinguish from *H. cordifolium*. As a rule, however, the old typical shoots from the previous year may be found at the bottom of the tuft, from whence the *cordifolium*-like shoots proceed. Near Grunnavik *H. cordifolium* grew abundantly on boggy, partly inundated ground, and there it was richly fruiting. On the damp ground it was flaccid and prostrate, in water erect in large, deep cushions.

312. *Hypnum Richardsonii* (Mitt.) Lesq. et James.

Amblystegium Richardsonii Lindb.

E. Iceland: Skorastadr (H.J.)! fr.; Seydisfjörður!, abundantly at an altitude of 350 metres. N. Iceland: Thorodstadaengjar (St.)!; Ljosavatn! fr., at an altitude of about 250 metres; Husavik!. NW. Iceland: Ármuli!. W. Iceland: Mödruvellir!, at an altitude of about 200 metres; Hjallaháls (H.J.)!. S. Iceland: Barkastadr!, at an altitude of 530 metres.

This species is probably more frequent than may be believed, judging from the few habitats, but it is often overlooked on account of its resemblance to the exceedingly common *H. cuspidatum* and *H. giganteum*. It grows in bogs, often abundantly, associated with *H. stramineum*, *H. sarmentosum*, *H. revolvens*, *H. exannulatum*, etc., and often sets fruit which ripens in the middle of July.

313. *Hypnum giganteum* Schimp.

Amblystegium giganteum De Not.

Very common.

Grows in bogs, where it is often the most abundant constituent of the vegetation, especially in the wettest situations, in channels and pools. Near Akureyri it was common in bogs even at an elevation of 600—700 metres. Fruit, which occurs rather frequently, ripens in the first half of July.

314. *Hypnum stramineum* Dicks.

Amblystegium stramineum De Not.

Very common over the whole of Iceland.

It grows on damp ground, usually intermixed in tufts of other *Hypnum* spp., *Sphagna*, *Cinclidium*, *Mnium*, etc. On very wet ground it often forms pure extensive growths. Thus, near Ljosavatn, it grew in the wettest parts of a bog at an altitude of 400 metres, in extensive, richly fruiting mats, 10—20 cm. deep. In depressions in the rocky flat it forms in association with *H. sarmentosum*, *H. revolvens* and *H. exannulatum* low, dense almost black growths.

Fruit was ripe near Ljosavatn on July 18th.

315. **Hypnum sarmentosum** Wahlb.*Amblystegium sarmentosum* De Not.

Commonly distributed on boggy ground, but as a rule not plentifully, mixed with other *Hypnaceæ* or in unmixed tufts.

It varies considerably in size and colour. The slender High Alpine forms, which occasionally form the bulk of the vegetation at an altitude of 500–700 metres, sometimes approach so close to *H. stramineum* that it may be difficult to keep these two species distinct from each other.

In S. Iceland it has been found in many places from about 300 metres upwards, but it has not been found in the low land. In the other parts of Iceland it is distributed from the low land up to about 700 metres above sea-level, but appears to be most frequent above a height of about 200–300 metres. It has been collected in fruit near Hof in E. Iceland, Ljosavatn in N. Iceland where it occurred abundantly in bogs at an altitude of about 250–300 metres, and near Grunnavik in NW. Iceland where it was the most abundant constituent of the vegetation in a bog. The fruit, in the specimens from all these localities, was green in the middle of July.

316. **Hypnum trifarium** W. et M.*Amblystegium trifarium* De Not.

E. Iceland: Seydisfjörður!; N. Iceland: Vatnsskard!.

In both the above localities it was growing rather scantily on very wet boggy ground, in company with *Hypnum scorpioides*, *H. stramineum* and *H. revolvens*.

317. **Hypnum turgescens** Th. Jensen.*Amblystegium turgescens* Lindb.

E. Iceland: Djupivogur!. N. Iceland: Svinadalur!. S. Iceland: Barðkarstadr!, at an altitude of 530 metres.

It grew everywhere abundantly on boggy ground, in company with *Hypnum revolvens*, *H. scorpioides* and *H. polygamum*.

318. **Acrocladium cuspidatum** (L.) Lindb.*Hypnum cuspidatum* L.

Very common.

This species grows on more or less damp ground, especially in bogs and damp meadows, but also in the water itself in moss bogs and pools, or on damp rocks. As a rule it does not ascend higher than 250–300 metres above sea-level. In S. Iceland it has been found, however, in several places up to a height of about 500 metres.

Fruit, which occurs rather frequently, was ripe about July 1st.

319. **Scorpidium scorpioides** (L.) Limpr.*Amblystegium scorpioides* Lindb.

Very common.

It usually grows in the wettest parts of the bogs, often in the water itself, in association with *Hypnum giganteum* and *H. exannulatum*. In the greater part of the country it is met with everywhere in such localities; only in SW. Iceland (Fljótshlíð and Eyjafjall) does it appear to be less frequent. It appears only by exception to ascend higher than about 300 metres, near Seyðisfjörður it was collected at an altitude of 400 metres. Only sterile specimens have been found.

320. **Hylocomium proliferum** (L.) Lindb.*Hylocomium splendens* (Hedw.) Br. eur.

Very common.

This species is found especially on a dry substratum, for instance on slopes, amongst grass, in heath-soil or as the most abundant constituent of the moss-covering on stones and in coppices. It occurs however also on damper ground, intermixed in tufts of *Sphagnum*, *Sphaerocarpus palustris*, *Racomitrium hypnoides*, etc., in bogs. *Hylocomium proliferum* is of almost equal frequency at all altitudes. Near Akureyri it was collected at an altitude of 990 metres. Only sterile specimens have been found.

321. **Hylocomium pyrenaicum** (Spruce) Lindb.*Hylocomium Oakesii* (Sull.) Schimp.

S. Iceland: Krisuvík (Stp.)!

322. **Hylocomium parietinum** (L.) Lindb.*Hylocomium Schreberi* (Willd.) De Not.

E. Iceland: Berufjörður!; Hornafjörður!. S. Iceland: Common everywhere!. Vestmannaey! W. Iceland: Esja (Gr!;!); Stykkishólmur!; Borgarfjörður!. NW. Iceland: Common!.

Widely distributed in SE., S. and W. Iceland and on the peninsulas of NW. Iceland. In E. Iceland it has not been found north of Berufjörður, and it appears to be absent from the whole of N. Iceland. It usually grows on rather dry ground, for instance in birch coppices, where it almost everywhere forms an essential part of the vegetation, and on moss-grown slopes and in the *Racomitrium*-heath, but it occurs also on damper ground, especially on knolls in bogs. It rarely ascends higher than the birch. In NW. Iceland it was collected up to about 300 metres above sea-level, and in Esja it grew among *Racomitrium*

hypnoides at an altitude of about 450 metres. Only sterile specimens have been found.

323. *Hylocomium loreum* (L.) Br. eur.

W. Iceland: Esja (Gr.;!), common up to about 400 metres above sea-level; common in the coppices of the district of Borgarfjörður!; Berserkjarhraun; Arnarbotn; Budahraun (H. J.); Stykkisholmur!; Brynjúdalur (Gr.;!); Hafnarfjörður (Gr.;!); Svinahraun!; Kolvidarhol!, up to about 350 metres. NW. Iceland: Sugandafjörður!, up to about 250 metres; Dýrafjörður!, up to about 200 metres. S. Iceland: Widely distributed!; Thingvellir!; Laugardalur!.

Widely distributed in the whole of the southern and south-western part of Iceland as far as Borgarfjörður and Snæfellsnes. It also occurs rather plentifully in some of the fjords of the north-west. It grows sometimes in clefts among fallen blocks of rock, sometimes on slopes together with other *Hylocomium* spp., *Dicranum scoparium*, *Rhacomitrium* spp., etc., or in the birch coppices. It was collected in fruit near Holt in S. Iceland, where a few old, empty capsules were found.

324. *Hylocomium triquetrum* (L.) Br. eur.

Iceland (Koenig). E. Iceland: Frequent from Berufjörður southwards!. N. Iceland: Asbjörgi!; near Eyjafjörður (O. D.;!); Ljosavatn (Gr.;!); common west of Blóndudalur!. NW. Iceland: Rather common in all the fjords!. W. Iceland: Rather common everywhere (Gr.;!). Vestmannaey! S. Iceland: Common!.

Commonly distributed from Berufjörður in E. Iceland throughout the whole of S., SW. and W. Iceland, and in the majority of the fjords of the north-west. It is rather rare in North Iceland proper, east of Blóndudalur, and occurs, as a rule, only scantily in the coppices or in the *Betula nana* heath.

Its growth is similar to the other species of *Hylocomium*, with which it is almost always found associated, especially in coppices and on moss-grown slopes. It has the same altitudinal distribution as *H. loreum* and *H. parietinum*, as it hardly ascends higher than to the upper limit of the birch. In Esja it is common up to 350–400 metres, near Kolvidarhol it was found in company with *H. loreum* at 350 metres, and in NW. Iceland it everywhere accompanies the birch to its upper limit at about 250 metres. Only sterile specimens have been found.

325. *Hylocomium squarrosus* (L.) Br. eur.

Very common over the whole of Iceland.

It grows both on a damp substratum, on stony flats as on boggy ground, and on a more dry substratum, associated with other *Hylocomium* spp., *Hypnum uncinatum*, etc. It is most frequent in the low land, but occurs, however, also at rather considerable altitudes. In Berufjardarskard it was found even at 500–600 metres, near Dýrafjörður at 330 metres and in S. Iceland in many places up to about

500—550 metres above sea-level. Only sterile specimens have been found.

325. **Hylocomium rugosum** (Ehrh.) De Not.

Widely distributed on dry grass or moss-grown slopes or flats, usually mixed with other Bryophyta such as *Hylocomium parietinum*, *H. proliferum*, *H. squarrosum*, *Rhacomitrium hypnoides*, *Dicranum scoparium*, *Ptilidium ciliare*, etc., rarely unmixed in large mats. It has the same altitudinal distribution as *H. triquetrum*, and hardly ascends higher than about 300—400 metres above sea-level. Only sterile specimens have been found.

II. THE BRYOPHYTE COMMUNITIES.

As in the other Arctic and Sub-arctic countries, the Bryophyta play a very important part in the plant-covering of Iceland. They occur either as an essential component of, so to speak, all plant associations, and often in far greater numbers as regards species and individuals, than do the higher plants, or as distinct Bryophyte associations from which other plants are entirely absent, or in which they occur only as a subordinate component.

As a basis of classification it comes natural to distinguish between (1) Lowland Formations and (2) Highland Formations. Within these two main groups the formations are again arranged according to their water-requirements, commencing with those which are the most water-loving. Naturally, no sharp limit can be drawn between these formations; on the contrary, all possible transitions between them are constantly met with, which makes a comprehensive survey extremely difficult. In addition to this, the investigations are in many respects very incomplete, especially with regard to the history of development of the Bryophyte associations. Also, several of the formations occur both in the Highlands and in the Lowlands. This is especially the case with decidedly xerophilous formations like the *Rhacomitrium* heath and, partly, also other moss-heaths.

Mountain plateaus and slopes situated above the growth-limit of the birch and the heather moor are in this paper considered as belonging to the Highlands (the Alpine Region). The limit in question may lie at various levels and can, of course, never be drawn sharply, but is in many cases dependent on the structure of the mountains. The flat land along the coasts and at the bottom of the valleys rises, as a rule, in terraces inwards towards the high

land. As far upwards as about 200—400 metres the slopes and flats are covered with heaths and birch-coppices or bogs respectively. Then usually follow steep, bare slopes of gravel or abrupt cliffs, and the plateaus which follow these bear the scanty plant-covering of the rocky flat.

The conditions, however, differ somewhat in different parts of the country. In NW. Iceland there is almost no low land with the exception of the narrow stretch of coast along the narrow, deep fjords. The steep, often vertical cliff-faces rise to a height of 500—600 metres and have a talus of *débris* (Urd) at their foot, and cliffs rising in terraces occur almost exclusively at the head of some of the fjords. The entire surface at the top of the mountain belongs to the rocky flat, and the associations characteristic of the latter often occur on the slopes and flats right down to the level of the sea, especially on slopes facing north.

In S. Iceland, on the other hand, in sheltered valleys, localities are met with as far upwards as 500—600 metres above sea-level, which, according to the composition of the plant-covering, must be referred to the Lowland formations.

I. THE LOWLAND FORMATIONS.

The Littoral Bryophyte Vegetation.

There are only very few species which are restricted to the immediate vicinity of the sea, or which grow by preference in the neighbourhood of the coast. *Schistidium maritimum* and *Ulota phyllantha* doubtless occur wherever there are rocky coasts, and are rarely found many hundred metres from the coast. They chiefly occur along the sea-coast itself, and at the entrance to the larger fjords, and decrease in frequency inwards towards the head of the fjord. Near Berufjörður, for instance, both species are very common around Djupivogur, but are entirely absent from the inner part of the fjord, and this is also the case in Seydisfjörður. Around the broad Isafjörður they are common as far inwards as Arngerdareyri, but are, as a rule, absent from the narrow branch-fjords. Both species grow on the coast rocks, but also frequently descend to the ground. On the island of Vestmannaey *Ulota* was very common on knolls in fields, where the grass-covering had been torn up by the wind, and *Schistidium maritimum* has been found in several places on damp sandy soil.

Orthotrichum Blyttii occurs here and there on coast rocks, or at any rate in the immediate neighbourhood of the coast. *Pottia Heimii* is commonly distributed along all flat coasts and *Amblystegium littorale* occurs here and there on damp sandy soil.

Besides these littoral species proper, there are several others which occur especially abundantly on the coast, but are also distributed in many other localities. *Bryum argenteum* and *B. capillare* grow especially below cliffs inhabited by sea-fowl, but their presence there is, no doubt, as much due to the abundant supply of organic manure as to the proximity of the sea. *Desmatodon latifolius*, *Leptobryum pyriforme* and *Tortula ruralis* are also typical of damp sandy soil and *Hypnum polygamum* of saline, boggy soil. On damp sandy soil on the beach low, scattered moss-cushions consisting of stunted individuals of many different and more casual species are often met with, for instance, *Distichium montanum*, *Didymodon rubellus*, *Ceratodon purpureus*, *Encalypta rhabdocarpa*, *Myurella julacea*, *Bryum* spp., etc.

Hydrophilous Bryophyte Formations.

The water originating from rain and mist or from melting snow will, according to the local conditions and the inclination, either spread out over the ground and — if it consists of humus or sand — sink into it, or seek outlets in brooks and rivers. Where the water remains standing without being able to find a sufficient outlet, a bog vegetation is developed, or, in deeper hollows, a lake is formed. Part of the water which sinks down to the solid rocky substratum continues its way downwards along the latter until it sooner or later issues as a spring. Stagnant water contains humus substances, is not well aerated, and is warmed by the sun, while running water, both in streams and springs, is pure and clear and contains oxygen and carbonic acid. Running water has a very low temperature during the summer, at the most 4°—6°. Therefore the composition of the vegetation on boggy ground differs entirely from that on ground along streams and near springs, inundated or saturated by the pure water.

The hydrophilous formations may be classified as follows:

- A. The Bryophyte Vegetation of Pure Water.
 - a. The Bryophyte Vegetation of Running Water and of Lakes.
 - b. The Bryophyte Vegetation of Inundated Gravelly Soil (slightly inclined ground and banks of streams).
 - c. The Bryophyte Vegetation on Muddy Soil near Springs (Dy).
- B. The Bryophyte Vegetation of Boggy Soil¹.
- C. The Bryophyte Vegetation of Damp Sandy Soil.
- D. The Bryophyte Vegetation near Hot Springs.

The Bryophyte Vegetation of Running Water and of Lakes.

The Bryophyte Vegetation of Lakes is extremely scanty, and often entirely absent. Along the shores of shallow lakes the surrounding swamp-vegetation may extend right into the water, especially species such as *Hypnum giganteum*, *H. exannulatum* and *H. scorpioides*, while rocky shores are usually quite bare of submerged Bryophyte vegetation or bear, here and there, one or other of the species growing in streams, such as *Fontinalis antipyretica* or a *Hypnum*-species. How far Bryophyta (for instance, *Fontinalis*) may occur in deeper water has not been investigated.

Glacier-rivers, on account of their torrential current and changeable course, as well as of the low temperature of their clay-containing water, are entirely devoid both of Bryophyte vegetation and of higher plants.

Brooks and Rivers. Where the bottom consists of loose gravel and smaller stones which are kept by the water in constant motion, Bryophyte vegetation is entirely absent. But if the bottom is of firm rock or larger stones it is, as a rule, covered with extensive moss-carpets which usually consist of *Hypnum ochraceum* or *Fontinalis antipyretica*, which may, either separately or together, cover large areas of the bottom. In very strong currents *H. ochraceum* forms the highly elongated and often thread-like var. *filiforme* which, together with *Rhynchostegium rusciforme* var. *atlanticum*, is a characteristic species of torrential rivers on much inclined ground. *H. ochraceum* var. *filiforme* is found especially in larger streams, where it is then the only species occurring, while *Rhynchostegium*

¹ In this paper no distinction has been made between swampy soil, marshy soil and boggy soil, the term "boggy" includes all three kinds of soil. The Danish term in all three cases is "sumpet".

appears to prefer smaller rivers with large loose blocks of rock at the bottom.

Several other Bryophyta occur either mixed with the above or occasionally as dominants in the Bryophyte vegetation. *Schistidium rivulare* is very common and often occurs abundantly. *Hypnum dilatatum*, *H. alpinum* and *H. alpestre* are common in the northern and eastern parts of the country, but are absent from or are rare in other parts. In the river Ellidará near Reykjavik the bottom was in several places covered with *Fontinalis androgyna*. In shallower water, and especially on inundated rock-surfaces in waterfalls, several other species also occur. Almost everywhere in such localities are found: *Haplozia cordifolia*, *Scapania undulata*, *Brachythecium rivulare*, *Rhynchostegium rusciforme*, *Hypnum palustre*, *H. falcatum*, *Philonotis fontana*, *Mniobryum albicans* var. *glacialis*, *Bryum Duvalii* and *Bryum ventricosum* together with some of the species which thrive best in places where they are outside the water during a part of the year.

Stones and rocks which protrude above the surface of the water and are inundated only during specially high water-levels are usually covered with a dense moss-carpet consisting of numerous species. In addition to the majority of the species of river-bottoms there occurs also an abundance of those belonging to damp rocks. Among the species which are rarely absent from such localities may be mentioned: *Hypnum falcatum*, *H. filicinum*, *Schistidium rivulare*, *S. gracile*, *Rhacomitrium aciculare*, *R. sudeticum*, *Blindia acuta*, *Dichodontium pellucidum*, *Amphidium Mougeottii*, *Haplozia atrovirens* and *Mnium punctatum*, and in North and East Iceland, in addition to the above-mentioned, *Philonotis seriata* and *Hypnum decipiens* are to be found. A somewhat different vegetation occurred in the river Rekyrdalsá in SW. Iceland, which is so well supplied from hot springs that in the beginning of June the water had a temperature of about 12°, while that of the streams flowing into it on both sides was only 4°—5°. *Hypnum ochraceum*, which is elsewhere so common, was entirely absent, and *Schistidium rivulare* occurred very scantily. On rock-surfaces and larger stones *Hypnum palustre*, *Brachythecium rivulare* and *Rhynchostegium rusciforme* grew abundantly, the last had also set fruit. *Fontinalis longifolia* covered the bottom in many places, and on stones protruding above the surface of the water *Hypnum filicinum* and *Schistidium gracile* were growing. In the cold tributary streams the usual vegetation occur-

red, consisting of *Hypnum ochraceum*, *H. falcatum*, *Schistidium rivulare*, *Rhynchostegium rusciforme* var. *atlanticum* and *Scapania undulata*.

The Bryophyte Vegetation of Inundated Gravelly Soil (slightly inclined ground and banks of streams).

Where the water flows down the mountain sides and spreads over slightly inclined gravelly ground, and along the flat banks of streams which are periodically inundated, a vegetation composed mainly of Bryophyta is developed. The most conspicuous species growing on this gravelly ground, and one which is hardly ever absent, and is often the most abundant constituent of the moss carpet, is *Philonotis fontana*, and after it this community may be designated the *Philonotis* association (Ostf., 1907). Very frequently many other species also occur, either as an admixture in the *Philonotis* carpet, or replacing it over smaller or larger areas. In NW. Iceland *P. fontana* is often replaced by *P. seriata*. *Mniobryum albicans* var. *glacialis* is almost as common as *Philonotis*; and *Bryum ventricosum*, *B. Duvalii*, *Brachythecium rivulare* and *Acrocladium cuspidatum* are also among those species which are rarely absent.

As a few examples will best show the composition of this vegetation, the following are given: —

1. The Ellidará near Reykjavik: The mossy fringe along the banks consisted of *Philonotis fontana*, *Dichodontium pellucidum* and *Acrocladium cuspidatum*.

2. Husavik, along a stream: A broad belt of *Cinclidium stygium* together with some *Paludella squarrosa*.

3. Husavik, along the banks of smaller streams on a slope: *Mniobryum albicans* var. *glacialis*, *Mnium punctatum*, *Philonotis fontana*, *Marchantia polymorpha* together with some *Bryum Duvalii* and *Thuidium lanatum*.

4. Berufjördur, along a stream: *Philonotis fontana*, *Mnium Seligeri*, *Hypnum giganteum* and *Mniobryum albicans* var. *glacialis*.

5. Svinaskard, along a small stream: *Philonotis seriata*, *Scapania undulata*, *Chiloscyphus polyanthus* and *Pellia Neesiana*.

6. Kaldalon (NW. Iceland), in a small stream and on gravelly ground over which water was flowing: *Philonotis seriata*, *P. fontana*, *Dicranella squarrosa*, *Mniobryum albicans* var.

glacialis, *Bryum Duvalii*, *Chiloscyphus polyanthus* var. *fragilis*, *Harpanthus Flotowianus* and *Pellia Neesiana*.

7. Kaldalon, along the banks of a stream: *Hypnum callichroum*, *Sphagnum teres*, *Harpanthus Flotowianus* and *Cephalozia bicuspidata* var. *Lammersiana*.

8. Reykjavik, on ground over which water was flowing: slightly inclined surface with streamlets. The banks of the streamlets were fringed with *Philonotis fontana*, *Mnibryum albicans* var. *glacialis*, *Bryum ventricosum*, *B. Duvalii* and *Acrocladium cuspidatum*.

9. Gnupsdalur (NW. Iceland), gravelly ground, over which water was flowing, streamlets flowing down the sides of the valley: *Philonotis seriata*, *P. fontana*, *Dicranella squarrosa*, *Haplozia cordifolia*, *Chiloscyphus polyanthus* var. *fragilis*, *Scapania undulata* and *S. paludosa*. *Haplozia* formed large black or greenish-black, and *Scapania paludosa* very large reddish-brown patches in the water, which was a few centimetres deep.

In North Iceland several species of *Hypnum* occurred abundantly in gravelly soil over which water was flowing, and often formed pure Hypneta. Especially do *Hypnum exannulatum* var. *purpurascens*, *H. falcatum*, *H. decipiens* and sometimes *H. stramineum* and *H. samentosum* occur in such localities.

The Bryophyte Vegetation on Muddy Soil near Springs (D₅).

The bright-green moss-carpet around and below the point of issue of the springs described by Helgi Jónsson (1900, p. 24: 1895, p. 73) as moss bogs (Icelandic D₅) are one of the most frequently occurring and characteristic plant communities of the Arctic and Sub-arctic regions. They were first mentioned by Grönlund (1877, p. 330) as mats of sapgreen mosses along small streams on mountain sides, consisting of *Bartramia fontana*, *Webera albicans*, *Brachythecium rutabulum* var. *rivulare* and *Hypnum uncinatum*, a description which includes both the moss bogs and the moss vegetation along smaller streams, which have also much in common.

Moss bogs develop in muddy soil, in all places where the ground water emerges as springs. They occur both on mountain slopes and at the bottom of valleys, occasionally also at higher levels, on rocky flats, but they are especially numerous on the lowest mountain slopes and in the flat boggy land below these

slopes. There they lie irregularly scattered in bright-green patches, differing greatly in size, and conspicuous even at a distance by their colour which is distinct from that of their surroundings. Higher up on the slopes at the foot of the bluffs, they frequently form continuous belts in connection with the mossy fringe along the downward-flowing streams (Helgi Jónsson, 1900, p. 25).

The vegetation consists of nearly the same species as those found on inundated gravelly soil, and the external conditions for the plants are also essentially the same in both places, since it is the cold, well-aerated water which determines the composition of the vegetation. During summer the temperature of the water is usually only 4°—5°, and this low temperature acts as a great check to the growth of higher plants, and is therefore indirectly favourable to the moss vegetation. The difference between the two vegetations is especially due to the substratum, that of the vegetation of inundated ground and stream-banks consisting of gravel, while the moss bog develops on mud. For this reason also, some of the species which occur in the gravelly soil are absent from the moss-bogs proper, for instance *Hypnum falcatum*, *H. decipiens*, *Dicranella squarrosa*, *Philonotis seriata*, *Haplozia cordifolia*, *Scapania paludosa* and *Chiloscyphus polyanthus* var. *fragilis*.

On flat ground moss bogs are, as a rule, almost circular in shape, and the species are arranged concentrically around the point of issue of the spring, whence the water gradually oozes through the moss carpet, and spreads out over the surrounding boggy ground. On sloping ground the moss bog is usually oblong in shape, and the spring emerges at its upper end (Fig. 19).

In the majority of cases the Bryophyte vegetation near springs (the Dý) is a *Philonotis-Mniobryum* association, in which other species of Bryophyta and a few higher plants occur scattered (Ostf., 1907, p. 69). On the soft mud around the point of issue of the spring — and often covering the latter — *Mniobryum albicans* var. *glacialis* usually grows, and outside the latter there is a broad belt of *Philonotis fontana*, which may be intermixed with or replaced by other mosses; and scattered in the moss carpet are a few flowering plants and vascular cryptogams, especially *Montia rivularis*, *Saxifraga stellaris*, *Epilobium* spp. and *Equisetum palustre*.



Fig. 19. Kaldalon (NW. Iceland). Slightly inclined ground below the stony slope. The light-coloured stripes are moss bogs, the darker, boggy ground or, on somewhat higher levels, patches covered with *Vaccinium-Empetrum* heath.

Besides the above-mentioned mosses the following plants are characteristic of the moss bog: —

<i>Brachythecium rivulare</i>	<i>M. Seligeri</i>
<i>Acrocladium cuspidatum</i>	<i>M. cinclidioides</i>
<i>Hypnum Kneiffii</i>	<i>M. affine</i> var. <i>elatum</i>
<i>Bryum ventricosum</i>	<i>Marchantia polymorpha</i>
<i>B. Duvalii</i>	<i>Pellia Neesiana</i>
<i>Mnium punctatum</i>	

But also other Bryophyta from bogs may occur intermixed with these, especially towards the edge, where the moss bog gradually passes into the common bog-vegetation. But of course all possible transitions also occur, between moss bog and bog vegetation as well as between moss bog and the vegetation of the banks of streams, all according to the nature of the underlying substratum.

As some examples will best show the composition of the moss bogs, the following are given: —

1. Seydisfjörður, numerous moss bogs on an almost hori-

zontal, boggy surface, below the slope of the mountain (Fig. 20). The vegetation was almost identical in all of them: In the middle, *Mniobryum albicans* var. *glacialis* was found intermixed with *Montia rivularis*, then came a belt of *Philonotis fontana*, often greatly intermixed with *Marchantia polymorpha* and with scattered plants of *Saxifraga stellaris*, *Equisetum palustre* and *Epilobium* spp. In some moss bogs a pure Hypnetum composed of *H. exanrulatum* var. *purpurascens* or *H. Kneiffii* had been developed.

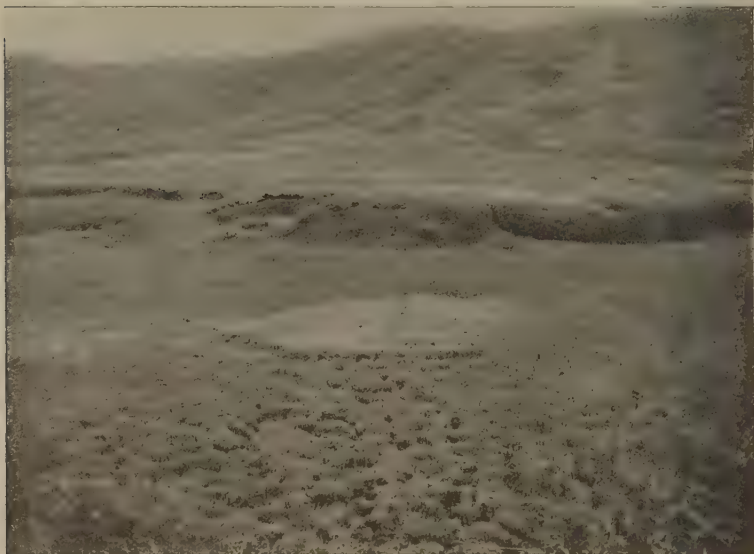


Fig. 20. Moss bog near Seydisfjörður. The light-coloured patch in the middle is *Mniobryum albicans* var. *glacialis*. In the foreground and on the sides *Philonotis fontana*.

2. Husavik, moss bog on slightly inclined ground: In the middle *Mniobryum albicans* var. *glacialis* and *Marchantia polymorpha* were found, and around this a belt of *Bryum ventricosum* f. *major*, *Mnium affine* var. *elatum* and *Philonotis fontana*, and outside it all an almost pure belt of *Philonotis*.

3. Breidabolstadr, slightly inclined grassland with scattered moss bogs: In the middle *Mniobryum albicans* var. *glacialis* grew intermixed with *Bryum ventricosum* f. *major*; around this was a belt of *Philonotis fontana*, and outside it all *Mnium affine* var. *elatum* and *Acrocladium cuspidatum*. Some smaller moss bogs below the slope

were composed of *Brachythecium rivulare*, *Mniobryum albicans* var. *glacialis*, *Philonotis fontana*, *Bryum ventricosum*, *Mnium Seligeri* and *Mnium affine* var. *elatum*, which grew in patches intermixed.

4. Holt (S. Iceland), moss bog below a slope: *Acrocladium cuspidatum*, *Mniobryum albicans* var. *glacialis*, *Bryum ventricosum* f. *major*, *Mnium punctatum*, *M. Seligeri* and *Pellia Neesiana* grew intermixed, sometimes as single plants and sometimes in patches. In the middle *Montia rivularis* grew among the mosses.

The majority of the mosses growing near springs form special cold-water forms which are particularly characterized by their highly elongated, slightly branched stems of almost equal height, by which feature they all assume a homogeneous habit. *Brachythecium rivulare* forms a form with long, erect shoots of equal height and with appressed leaves. *Philonotis fontana* forms, when growing in very cold water, a highly elongated, hardly tomentose form with appressed, shortly pointed leaves with short leaf-cells and very broad nerve (forma *adpressa*). The cold-water form of *Bryum ventricosum* (f. *major*) is also higher in growth and more vigorous than is the bog-form, has stems bare of tomentum with large and broad, spreading leaves. *Mniobryum albicans* var. *glacialis* is also much more vigorous than the type, with larger and broader leaves. *Mnium* spp. develop *elatum*-forms with erect, sterile shoots of equal height.

The Bryophyte Vegetation of Boggy Soil.

The bog vegetation is extensively distributed about Iceland, especially in the low land, and in many places it occupies almost the whole tract of land between the mountain slopes and the sea. The lower mountain plateaus and slightly inclined slopes up to a height of about 300—400 metres are also to a great extent covered with bogs (Sedge-bogs). The mode of formation of these bogs has been described by Helgi Jónsson (1895, p. 45). They originate partly from the further development of the vegetation of the springs and the banks of streams, and partly from shallow lakes first forming in depressions and afterwards becoming gradually filled up with plants in connection with sand transported by the wind. In the former case a drier bog (mýri, pl. mýrar) is formed, the sedges superseding the mosses; in the latter case a wet bog (flói, pl. flóar) is first formed, which, by gradually becoming overgrown with plants, develops into a "myri"¹.

¹ For a description of "myri" and "flói" see also Thoroddsen's Physical Geography of Iceland, ante p. 323.

In "Die Moose des Sarekgebietes" (1910, p. 248) C. Jensen classifies the bog vegetation in four formations: The Willow bog, the Sedge bog, the Moss bog and the Peat bog. This classification cannot be entirely adopted as regards Iceland. Willow bogs proper (willow coppices in boggy soil) do not appear to be developed there. True, scattered individuals or small groups of *Salix* (*S. lanata*, *S. phylicifolia* and *S. glauca*) are often found in the sedge bogs, especially in NW. Iceland, but the moss vegetation there does not differ in any respect from that of the surrounding sedge bog.

The vegetation of boggy soil is composed mainly of mosses and sedges, greatly varying in abundance. Sometimes the sedges are the dominant plants, and then the moss carpet is less conspicuous at the bottom, among the *Carex* and *Eriophorum* spp.; sometimes there is a continuous moss-carpet in which the higher plants grow scattered, and then the one formation may be termed a sedge bog, and the other a moss bog, which, however, does not correspond with Helgi Jónsson's definition of a moss bog, but appears to agree with Warming's description (1887, p. 132). They are the same mosses which occur in the same manner in both formations, and all possible transitions are found between these.

Helgi Jónsson (1900, p. 20; 1905, p. 9) classifies the bog vegetation into Star-grass bogs and Moss bogs. The latter, which include the vegetation along streams, on inundated ground and near springs (Dý), and also some of the moss bogs in Warming's definition, have been treated in the preceding section. The star-grass bogs are again divided into "Mýrar" and "Flóar". In the Mýri the ground water stands on a level with the surface, the soil contains acid humus and is so closely interwoven with rhizomes and roots that it bears one like a carpet. In the Flói the ground water stands above the surface, the soil is muddy and produces a more scattered vegetation of *Carex* and *Eriophorum* tufts. As it is chiefly the height of the ground water which determines whether a Mýri or a Flói is developed, and the Flói is formed by the filling up of a shallow lake, there occur all transitions between lake and Flói, and through further development, between Flói and Mýri.

The Flói is poor in mosses. The soft muddy soil is not favourable to their growth, and it is only as an exception that some of the species are found which grow along the banks of lakes, but often the moss-covering is entirely absent. *Hypnum scorpioides* and *H. giganteum* are the most frequent species which

occur everywhere in pools and channels. *Hypnum exannulatum*, *H. revolvens* var. *Cossoni* and *Acrocladium cuspidatum* are also frequent. In many places in East Iceland *Cinclidium stygium* was found abundantly in Flóar, while *Hypnum cordifolium* and *H. fluitans* were found in a few places only.

The moss-covering of the Mýri is characterized by the fact of its being rich in species, which grow sometimes greatly intermixed, sometimes separately in large and small patches. The ground is usually knolly, and there is a great difference in the vegetation between and upon the knolls, the most hygrophilous species growing on the wet ground between the knolls, while on the top of the knolls mesophilous and xerophilous forms are met with, and between these all transitions occur, according to the height of the knoll and the degree of moisture. They are nearly the same species which are everywhere the most abundant constituents of the Mýri vegetation. The following species occur on the ground between the knolls: —

Musci veri

**Hypnum revolvens*
 * — *intermedium*
 * — *stramineum*
 * — *stellatum*
 * — *polygamum*
 * — *sarmentosum*
 * — *Lindbergii*
 * — *exannulatum*
 * — *giganteum*
 — *Richardsonii*
 — *falcatum*
 — *trifarium*
 — *turgescens*

**Camptothecium nitens*
 **Brachythecium rivulare*
 (*NE.) *Thuidium lanatum*
 **Acrocladium cuspidatum*
 **Philonotis fontana*
 **Meesea trichoides*

Sphagna

**Sphagnum teres*
 * — *rubellum*
 * — *Warnstorffii*
 * — *fimbriatum*
 * — *medium*
 * — *Girgensohnii*
 * — *subnitens*

Meesea triquetra
 **Paludella squarrosa*
 **Catoscopium nigrum*
 **Cinclidium stygium*
 **Mnium cinclidioides*
 * — *punctatum*
 * — *affine*
 * — *Seligeri*
 * — *subglobosum*
 **Bryum ventricosum*
 **Splachnum vasculosum*
 * — *sphaericum*
 (*NE.) *Dissodon splachnoides*
 **Oncophorus Wahlenbergii*
 * — *virens*
Dicranum angustum
 **Fissidens osmundoides*
 **Dichodontium pellucidum*
Campylopus Schimperii

Sphagnum papillosum
 — *inundatum*
 — *squarrosum*
 — *acutifolium*
 — *riparium*
 — *Lindbergii*

Hepaticæ

* <i>Pellia</i> <i>Neesiana</i>	* <i>Lophozia</i> <i>quinquedentata</i>
* <i>Aneura</i> <i>pinguis</i>	— <i>quadriloba</i>
* — <i>multifida</i>	— <i>Schultzii</i>
* <i>Cephalozia</i> <i>bicuspidata</i>	— <i>Hornschuchiana</i>
* — <i>pleniceps</i>	* <i>Scapania</i> <i>irrigua</i>
* <i>Cephaloziella</i> <i>Hampeana</i>	— <i>uliginosa</i>
* — <i>rubella</i>	— <i>undulata</i>
<i>Odontoschisma</i> <i>elongatus</i>	* <i>Blepharostoma</i> <i>trichophyllum</i>
* <i>Alicularia</i> <i>scalaris</i>	* <i>Anthelia</i> <i>julacea</i>
* <i>Lophozia</i> <i>Kunzeana</i>	

In the above list an asterisk is prefixed to those species which are common over the whole of Iceland, and which are met with in almost every considerable boggy tract. Some of the species are common in some districts and absent from others, for instance *Thuidium lanatum* and *Dissodon splachnoides*, which are very common in North and East Iceland, but are rare or entirely absent from other parts of the country, and *Campylopus Schimperii*, which is found only in the southern part.

The mosses often grow so much intermixed that a small collection may contain 15—20 or even more species, but often smaller and larger patches are found dominated by a single species. Thus *Catoscopium*, *Philonotis*, *Cinclidium* or *Mnium* bogs occur, in each of which one of these species is the dominant member. On very damp ground the mass of the vegetation is formed by, for instance, *Mnium cinclidioides* or *Cinclidium stygium*, and in South Iceland by *Mnium Seligeri*. In North and East Iceland it is especially *Thuidium lanatum* which is often the most conspicuous species.

Sphagnum spp. grow almost always in scattered tufts, and *Sphagnum* bogs proper are rarely met with. Helgi Jónsson (1900, p. 25) records such bogs from Snæfellsnes, where they occurred on sloping ground and were composed of *Sphagnum teres*, *S. Warnstorffii* and *S. Girgensohnii* intermixed with *Paludella squarrosa*, *Hypnum stramineum*, *Hylocomium squarrosum* and *Polytrichum commune*. I have only seen a similar vegetation near Barkarstadr in South Iceland, where, on a wet boggy slope stretching down towards a river, there was an almost continuous growth of *Sphagnum rubellum* and *S. Warnstorffii* intermixed with a few other mosses, especially *Thuidium lanatum*, *Hylocomium squarrosum* and *Hypnum stramineum*.

Sphagnum spp. often play an important part in the knoll-formation of the mýri, the large *Sphagnum*-cushions being inter-

woven with mosses and hepatics, and different plants such as *Vaccinium* spp., *Betula nana*, *Comarum palustre* and several *Carices* then establishing themselves upon these cushions.

The numerous hepatics which occur are everywhere found interspersed in the moss carpet, especially in that upon the knolls, and, as regards all the species mentioned below, doubtless also in the ground vegetation between the knolls.

The Bryophyte Vegetation of Knolls¹ is dependent upon the varying degree of moisture, which is greatest on the ground between the knolls and least in their uppermost part. Some of the Bryophyta of the ground do not ascend higher than to the base of the knolls, while others, especially many of the pleurocarpous mosses, occur with equal frequency upon and between the knolls. In addition to the latter mosses the following species are found upon the knolls: —

* <i>Hypnum uncinatum</i>	* <i>Mnium hornum</i>
— <i>imponens</i>	* <i>Rhacomitrium canescens</i>
* <i>Climacium dendroides</i>	* — <i>hypnoides</i>
* <i>Hylocomium squarrosum</i>	* <i>Ditrichum flexicaule</i>
* — <i>parietinum</i>	* <i>Dicranum scoparium</i>
* — <i>proliferum</i>	* — <i>congestum</i>
<i>Orthothecium chryseum</i> (N. Icel.)	* — <i>elongatum</i>
* <i>Polytrichum alpinum</i>	* <i>Lophozia lycopodioides</i>
* — <i>strictum</i>	* <i>Plagiochila asplenioides</i>
* — <i>juniperinum</i>	* <i>Ptilidium ciliare</i> ,
* <i>Aulacomnium palustre</i>	

and besides these, numerous other species which belong to other formations and must rather be regarded as casual visitors.

The following examples will show the composition of the bog vegetation in the different parts of Iceland: —

1. Skálholt in SW. Iceland. The country here over a wide expanse is covered with vast boggy areas in which small, protrud-

¹ According to my observations these knolls are formed either by soil accumulating in tufts of *Sphagnum*, etc., in which other plants take root, among others sedges, when soil again accumulates, or by soil accumulating directly around roots of sedge-tussocks. This accumulation of soil and plants continues till big knolls are formed, some 60—70 cm. in height. These knolls occur in all stages of development, from tufts or tussocks with a slight accumulation of soil around their roots to completely rounded knolls in which the tussocks have entirely disappeared. In Danish "Tue" stands both for "knoll" and for "tuft" and "tussock", which is very convenient when referring to one of the various stages of these "knolls". But the rendering into English has been difficult, though in each case the term most appropriate to the stage of development of the "knoll" has been carefully chosen.

ing masses of rock (holt) occur scattered. In the wettest parts of the mýri grew *Hypnum scorpioides*, *H. giganteum* and some *H. revolvens* v. *Cossoni*. The moss-covering of the ground between the knolls consisted mainly of *Hypnum revolvens*, *H. stellatum*, *H. Lindbergii*, *H. stramineum*, *Acrocladium cuspidatum*, *Hypnum polygamum*, *Hylocomium squarrosum*, *Camptothecium nitens*, *Mnium Seligeri*, *M. cinclidioides*, *Philonotis fontana* and *Bryum ventricosum*, all of which grew intermixed. Of more scanty occurrence were *Hypnum sarmentosum*, *Paludella squarrosa*, *Meesea trichoides*, *M. triquetra*, *Cinclidium stygium*, *Mnium punctatum*, *Splachnum vasculosum*, *S. sphæricum*, *Fissidens osmundoides*, *Oncophorus Wahlenbergii*, *Alicularia scalaris* and *Aneura pinguis*. The following hepatics grew both between and upon the knolls: — *Lophozia Kunzeana*, *L. quinquedentata*, *Scapania irrigua*, *Cephalozia pleniceps*, *C. bicuspidata* and *Cephaloziella Hampeana*. The knolls were usually formed by *Sphagna*, especially by *S. teres*, *S. Warnstorffii* and *S. rubellum*, and in very wet parts of the mýri also by *S. medium*. Woven into and above the *Sphagnum*-cushions grew *Hypnum uncinatum*, *Hylocomium squarrosum*, *H. proliferum*, *H. parietinum*, *Climacium dendroides*, *Aulacomnium palustre*, *Dicranum scoparium* var. *turfosum*, *Platidium ciliare*, *Plagiochila asplenioides*, and, uppermost, *Rhacomitrium hypnoides* and *R. canescens*.

2. Höskuldstadr in E. Iceland. Knolly sedge-bogs with a rich vegetation of mosses between the knolls, along the river at the bottom of the valley. The moss carpet of the ground between the knolls consisted of *Hypnum revolvens*, *H. giganteum*, *H. stellatum*, *Acrocladium cuspidatum*, *Mnium cinclidioides*, *Cinclidium stygium*, *Mnium affine* var. *elatum*, *Paludella squarrosa*, *Philonotis fontana*, *Meesea trichoides*, *M. triquetra*, *Bryum ventricosum*, *Aulacomnium palustre*, *Catoscopium nigrum*, *Oncophorus Wahlenbergii*, *Dichodontium pellucidum* and *Aneura pinguis*. All the Bryophyta, as a rule, grew intermixed, but some of them frequently formed large, pure growths, especially *Catoscopium nigrum* and in the wettest parts *Mnium cinclidioides* and *Cinclidium stygium*. Upon the knolls, which were sometimes formed by *Carex*, sometimes by *Sphagnum*, grew *Camptothecium nitens*, *Thuidium lanatum*, *Hypnum stramineum*, *H. uncinatum*, *Hylocomium squarrosum*, *Sphagnum teres*, *S. Warnstorffii*, and, uppermost, *Hylocomium parietinum*, *H. proliferum*, *Dicranum scoparium*, *Rhacomitrium hypnoides* and *Scapania curta*. Woven into the moss-covering, especially into that upon the knolls, were found *Lophozia Kunzeana*, *L. quinquedentata*, *Scapania irrigua*, *Blepharostoma tricho-*

phyllum, *Plagiochila asplenoides*, *Cephalozia bicuspidata* and *C. Hampeana*. The two sedge bogs described above may be regarded as types, and by far the greater majority of the sedge bogs have very nearly the same vegetation.

3. Breidabolstadr on Fljótshlid (S. Iceland). A flat, boggy tract of meadow-land beneath the low mountain-slope, intersected by ditches and, lowest of all, by a low dike in order to keep the water-level at a suitable height. The ground was even, without knolls, and covered by a vigorous vegetation of *Carices*, with a moss carpet at the bottom. Occasionally there were also patches where the moss-covering was dominant, and the species of *Carex* occurred in this as scattered individuals. The species were comparatively few in number and were usually dominant in spots. The most frequent species were *Philonotis fontana*, *Mnium Seligeri*, *M. cinclidioides*, *Cinclidium stygium*, *Bryum ventricosum* and *Acrocladium cuspidatum*. Here and there patches occurred with a more mixed vegetation, which, in addition to the plants mentioned above, consisted of *Hypnum revolvens*, *Meesea trichoides*, *Splachnum vasculosum*, *Lophozia quinquedentata*, and perhaps of several other species. Here and there were tufts formed by *Sphagnum rubellum* and *S. teres*.

A vegetation of about the same composition as that described above is very commonly met with in South Iceland, where tracts of meadow-land, by means of draining, irrigation or damming up, are kept at about the same ground-water level during the whole summer. The knolls disappear — or are not formed — and the moss-covering becomes poorer in species.

4. Ljósavatn in North Iceland. A rather large sedge bog on very wet ground, on the slightly inclined slope of the mountain. The moss-carpet was composed of *Cinclidium stygium*, *Mnium cinclidioides*, *M. Seligeri*, *Paludella squarrosa*, *Camptothecium nitens*, *Hypnum* spp., *Philonotis fontana*, *Bryum ventricosum*, *Thuidium lanatum*, *Lophozia Kunzeana* and *L. quinquedentata*. *Sphagnum rubellum*, *S. teres*, *S. Warnstorffii* and *S. Girgensohnii* occurred abundantly in large tufts. In the wettest parts, where the water reached above the surface, grew thick, extensive carpets of *Hypnum exannulatum*, *H. stramineum*, *H. sarmentosum*, *H. giganteum* and *H. Richardsonii*, all in very vigorous development, and in fruit. The *Hypnaceæ* sometimes grew intermixed, but usually they occurred separately, and were only slightly mixed with other Bryophyta and Cyperaceæ. This formation corresponds undoubtedly with C. Jen-

sen's *Amblystegium*-bog (1910, p. 253) and occurs rather commonly in North Iceland, but more rarely in the other parts of the country, probably because in North Iceland the climate is more continental than in the rest of Iceland. These moss bogs are most frequently composed of *Hypnaceæ*, but often *Paludella squarrosa*, *Cinclidium stygium* or *Mnium cinclidioides* forms an essential part of them.

5. Isafjördur. The narrow strip of land, below the steep mountain slope (almost 600 metres in height) along the western side of the fjord, is covered with sedge bogs right to the head of the fjord. The most abundant constituents of the moss carpet between the knolls were *Hypnum revolvens*, *H. giganteum*, *H. exannulatum*, *Paludella squarrosa*, *Philonotis fontana*, *Mnium cinclidioides*, *M. punctatum*, *Cinclidium stygium* and *Bryum ventricosum*. Here and there in the moss carpet grew *Thuidium lanatum*, *Catoscopium nigratum*, *Meesea trichoides*, *M. triquetra* (scantly) and *Oncophorus Wahlenbergii*. *Splachnum sphaericum* and *S. vasculosum* grew on cow-dung. The knolls were formed by *Sphagnum teres*, *S. Warnstorffi*, *Polytrichum strictum*, *P. alpinum*, *Mnium hornum* and *Dicranum scoparium*. The following hepatics occurred woven into the moss-cushions: *Lophozia quinqueidentata*, *L. Kunzeana*, *L. Hornschuchiana*, *L. quadriloba*, *Scapania irrigua*, *Blepharostoma trichophyllum*, *Harpanthus Flotowianus*, *Cephalozia planceps*, *Cephaloziella Hampeana* and *C. rubella*.

6. Seydisfjördur. A boggy flat at an altitude of about 350 metres. The ground was covered with a blackish-brown moss carpet composed of *Hypnum giganteum*, *H. stramineum*, *H. sarmenosum*, *H. revolvens*, *H. Richardsonii*, *H. exannulatum* and *H. uncinatum*, occasionally alternating with patches of *Mnium cinclidioides*. Tufts of *Sphagnum teres* and *S. Girgensohnii* occurred frequently, and *Splachnum vasculosum* was common on dung. *Carex* spp. and *Eriophorum* were abundant without, however, occurring so densely as to cover the ground. This type of *Hypnum* bog, from which other plants are most frequently entirely absent, is common in North and East Iceland at elevations of about 200—500 metres, on flats where the snow lies long. The moss carpet is, as a rule, thin and bears distinct traces of having been long subject to the pressure of the snow-covering, the old stems being pressed closely together, and only the annual shoots growing up into the air.

Peat Bogs. In the course of time sedge bogs usually develop into peat bogs. Gradually, as the peat layer becomes thicker, the dampness

of the surface decreases, the most hygrophilous species disappear and some other species, chiefly mesophilous, take their place. Some of the latter are especially connected with this soil. The most marked species of peaty soil are *Psilopilum lævigatum*, *Polytrichum gracile*, *P. juniperinum*, *Pogonatum polytrichoides*, *Mnium hornum*, *Catharinea undulata* (also in warm soil) and *Dicranella cerviculata*. Some species which occur on other soils, but most abundantly on peat, are *Philonotis tomentella*, *Pogonatum urnigerum*, *Funaria hygrometrica*, many *Bryum* spp. (especially *B. inclinatum*, *B. affine*, *B. arcticum*, *B. lacustre* and *B. pallens*), *Pohlia nutans*, *Leptobryum pyriforme*, *Distichium inclinatum*, *Ceratodon purpureus* and *Dicranella crispa*. The above-mentioned species are all mesophilous, a few are xerophilous also (for instance *P. juniperinum* and *Ceratodon*), and the majority of them occur also in sandy soil, but in Iceland the peat is often abundantly mixed with fine sand, transported by the wind. The two rare species, *Trematodon ambiguus* and *Pogonatum capillare* var. *dentatum*, have also been found on peat.

The most decided character-plant of peaty soil is *Psilopilum lævigatum*, which occurs everywhere on peat-flats which have been laid bare, and may, for instance, entirely cover the piled-up heaps of cut peat with its numerous capsules, often in association with *Funaria hygrometrica*. Another characteristic vegetation of localities like these consists of extensive bluish-green mats of low-growing, sterile *Pogonatum urnigerum*, interwoven with *Alicularia scalaris*.

The following examples will show the composition of the peat bogs in the different parts of Iceland: —

1. Seydisfjörður. In a peat bog intersected by ditches: *Psilopilum lævigatum*, *Leptobryum pyriforme*, *Pogonatum urnigerum*, *Polytrichum juniperinum* and *P. alpinum* grew abundantly. Inter-mixed with the above occurred *Bryum inclinatum*, *B. arcticum*, *B. purpurascens*, *Distichium montanum*, *Ceratodon purpureus*, *Scapania curta*, *Alicularia scalaris* and *Lophozia Wenzelii*.

2. Akureyri. Behind the town, at the foot of the mountain, were large expanses of bogs from which great quantities of peat had been removed. The bared flats and the piled-up heaps of cut peat were often entirely covered with *Psilopilum* and *Funaria*. Commonly occurring species were *Polytrichum gracile*, *P. alpinum*, *P. juniperinum*, *Leptobryum pyriforme*, *Bryum inclinatum*, *B. affine*, *B. lacustre*, *B. arcticum*, *Philonotis tomentella*, *Ceratodon purpureus*, *Dicranella crispa*, *Didymodon rubellus* and *Scapania irrigua*.

3. Grunnavik near Jökulsfjörður. A deep layer of peat, here and there intersected with ditches. The following mosses were observed: *Polytrichum alpinum*, *P. Swartzii*, *Mnium hornum*, *Pohlia nutans*, *P. cucullata* (both common), *Bryum purpurascens*, *Ceratodon purpureus*, *Dicranella cerviculata*, *D. crispa*, *Lophozia quinquedentata* and a few tufts of *Tetraplodon bryoides*. *Psilopilum lævigatum* was found only scantily and after a long search.

4. Lundur in W. Iceland. On a damp peat-flat, the uppermost layer of which was pared off, grew *Dicranella Schreberi*, *Aongstroemia longipes*, *Bryum lacustre*, *B. inclinatum*, *B. æneum*, *Dichodontium pellucidum*, *Philonotis fontana*, *Meesea trichoides* and *Aneura pinguis*.

The Bryophyte Vegetation of Damp Sandy Soil.

The damp sandy or gravelly ground along streams, inundated only in the case of especially high water-levels, is often covered with a moss carpet of a very mixed composition. Here liverworts play an especially important part, and very frequently pure liverwort associations are met with, or other associations in which the liverworts are almost dominant. They are almost everywhere the same species which are the most abundant constituents of the moss carpet. The following *Hepaticæ* are the most frequent: *Scapania subalpina*, *Alicularia scalaris*, *A. geoscypha*, *Lophozia quinquedentata*, *Cephalozia bicuspidata* var. *Lammersiana*, *Anthelia julacea*, *A. Juratzkana*, and, especially in NW. Iceland, *Harpanthus Flotowianus*. Intermixed with the above occur a very great number of species of which the most frequent are *Pellia Neesiana*, *Aneura pinguis*, *Haplozia atrovirens*, *Cephalozia pleniceps*, *Dicranella crispa*, *Dichodontium pellucidum*, *Aongstroemia longipes*, *Didymodon rubellus*, *Distichium montanum*, *Pohlia commutata*, *P. gracilis*, *Bryum pallens*, *B. inclinatum*, *B. affine*, *Philonotis tomentella*, *P. fontana*, *Pogonatum urnigerum* and *Timmia austriaca*. A few less common species, such as *Blasia pusilla*, *Eucalyx subellipticus* and *Distichium inclinatulum*, also belong to this community. Sometimes a moss-covering of another composition is also met with, *Racomitrium canescens* often forms extensive mats on wet sandy ground. In North Iceland *Timmia austriaca* and *Philonotis tomentella* are found plentifully in many places on the damp ground above the *Philonotis*-belt, as a rule abundantly mixed with other species. *Dicranella crispa* is also very often found in great quantities on damp sandy

ground. In North-west Iceland the development of the liverwort-mats was especially typical in many places (for instance in Gnupsdalur and near Isafjörður); they consisted chiefly of *Harpanthus Flotowianus*, *Alicularia geoscypa*, *A. scalaris*, *Cephalozia bicuspidata* var. *Lammersiana* and *Lophozia quinqueidentata*. Here *Oligotrichum hercynicum* also occurred abundantly in damp sandy localities.

On a somewhat damp, cold flat at the bottom of the fjord Kaldalon, below the Jökull, grew *Pohlia gracilis*, *Hypnum exannulatum* var. *brachydictyon*, *Philonotis tomentella* and *Eucalyx subellipticus*.

The Bryophyte Vegetation near Hot Springs.

Iceland abounds in hot springs: they are not, however, equally distributed over the whole country, but are most numerous in districts in which the most volcanic activity occurs. The majority of these hot springs are found in the south-eastern part of the country, on Reykjanes, around Reykjavik, in the south-western low land, and in several of the valleys of West Iceland, especially in Reykholtdalur. In North Iceland, the district around Mývatn is rich in hot springs, but they are also found scattered singly over the whole of this part of the country. They are absent from East Iceland, but a few occur in North-west Iceland, especially around Isafjardardjup. Groups of hot springs are found in several spots in the inner high land, but the Bryophyte vegetation around these is quite unknown.

The majority of the hot springs of Iceland have a rather high temperature, the water being most frequently at about boiling point. Springs, the temperature of which is not much higher than that of their surroundings, are found for instance around Isafjardardjup near Laugarbol (50° — 55°) and Nauteyri (25° — 30°), yet no characteristic vegetation had developed there. According to Thoroddsen such springs also occur north of Vatnajökull, and have a temperature which is not many degrees higher than their surroundings.

The hot springs in Iceland may be classified as belonging to two different groups, viz. the Alkaline Springs and the Sulphur Springs.

The Alkaline Springs (thermæ) usually occur in districts where there has been no recent volcanic activity. They contain pure, clear water which often deposits siliceous sinter, and are always surrounded by a luxuriant vegetation. When the temperature reaches

boiling point, they are called in Icelandic "hver" (plur. "hverar"), if the temperature is lower, they are called "laug" (plur. "laugar").

The Sulphur Springs (Icelandic "brennistenshverar") are most numerous in districts where the effect of the volcanic activity is still felt, for instance near Mývatn and in many parts of South Iceland. The water contains sulphuretted hydrogen. These springs deposit sulphur, and the soil around them is greatly decomposed by the acid vapours which arise, and is transformed to red or yellowish clay-masses. Sometimes, as for instance in Reykirdalur, they also deposit siliceous sinter. As a rule, a group of springs consists of either the one or the other kind of spring, occasionally, however, a few springs containing sulphuretted hydrogen may be found together with the alkaline springs. The vegetation around sulphur springs is always very scanty, since only a few species of plants can thrive where they are exposed to hot vapours containing sulphuretted hydrogen.

The "Laugar" near Reykjavik. The vegetation has been described by Ostenfeld (Bot. Tid., vol. 22, pp. 233 et seq.), who has not, however, mentioned the moss vegetation. When I visited the springs in 1909 and 1912 I found no characteristic moss vegetation. Since the warm water had been used for washing purposes the ground surrounding the spring had been much trampled upon, and further downwards towards the warm outlet only the usual bog species were found. Here *Philonotis fontana* alone formed the elongated slender form known also from other hot springs.

The Springs on Biskupstúngur. On the low boggy tract of land between the rivers Bruará and Túngufljót in South Iceland (Biskupstúngur, so called because the old episcopal residence — Skálholt — was situated there), there are, on both sides, along the rivers several hot springs of considerable size, or groups of hot springs of which Thorlákshver and Laugaráshver in the southernmost part, near Skálholt, and Sýdri Reykjahver, further northwards near the Bruará, have been investigated. They all contain pure water free from sulphuretted hydrogen, with the exception of a few small holes near Thorlákshver.

Thorlákshver (Fig. 21) is situated a few kilometres west of Skálholt, close to the east bank of the Bruará. It consists of one larger and several smaller holes, from whence the boiling water flows out and gathers together into a rather large brook, which flows into the Bruará. The vegetation along the sloping

banks of this brook and of the flat boggy surroundings (which are partly influenced by the heat of the soil, partly inundated by the hot water) is very luxuriant. Both around the basins of the springs and along the brook formed by the outlets of the springs, grew a



Fig. 21. Thorlákshver near Skálholt. In the background the river Bruará; behind the fence to the left is a potato field, where the temperature of the ground was about 25° . The chief outlet of the spring is just behind the small elevation to the left, and the outlet-channel is from the right straight across the foreground. The "peninsula", in the middle of the figure, surrounded by the hot water, is partly covered with *Sphagnum* (the light patch) and partly with *Hypnum*-mats (the dark patch).

broad belt of enormous yellowish brown and pale-green *Sphagnum*-cushions, 25 cm. deep, chiefly formed by *S. imbricatum* (yellowish brown), *S. teres* and *S. cymbifolium* (whitish green) interwoven with *Hypnum stramineum*, *Hylocomium squarrosum* and here and there with *Acrocladium cuspidatum*, *Hypnum imponens* and *H. Lindbergii*. The

surface of the *Sphagnum* cushions was usually covered with the orbicular, closely appressed leaves of *Hydrocotyle vulgaris*. The temperature in the *Sphagnum* cushions was rather high, on the surface of the ground as much as 50° , chiefly on account of their feeble heat-conducting power, and the tufts were quite saturated with the moisture from the warm vapours. The *Sphagnum*-belt did not extend so far as to the hot water, but everywhere there was a strip (10—20 cm. broad), nearest the water, covered with low dark-green mats of *Fossombronina Dumortieri*, occasionally intermixed with *Haplozia crenulata* or *Alicularia scalaris*. The same vegetation of *Hepaticæ* was in fact found in all places where the banks were too steep to allow *Sphagna* to gain foothold. The temperature under the *Fossombronina*-covering was, as a rule, about 40° (34° — 43°). Where the bank was flatter and on the warm, dry, clayey flats in the neighbourhood of the springs *Archidium phascoides* grew in great masses, and often formed, without intermixture of other species, extensive, dark-green mats, 1—2 cm. deep. It occurred also on the siliceous sinter deposited by the water, and here and there among the *Hepaticæ*. The temperature of the soil under the *Archidium*-mat was almost everywhere about 40° . In the brook formed by the outlet of the spring there was a small island which was partially inundated by the hot water, and here grew a great many large cushions of a peculiar form, a *Barbula fallax* (var. *lævifolia* n. var.), and in one spot, on the slope, in the neighbourhood of the basin, grew *Anthoceros punctatus* together with *Fossombronina*.

Outside the *Sphagnum*-belt the ground was perceptibly warm even for a tolerable distance, and the vegetation there was likewise greatly exposed to the warm aqueous vapours. There *Hypnaceæ*, in particular, grew very luxuriantly on the rather dry substratum. *Hypnum imponens* and *H. Lindbergii* were often almost the only species to be found there, the latter growing in a peculiar, erect form, almost branchless. The temperature of the ground under the *Hypnum*-covering was, as a rule, 25° — 30° .

A little below the spring the brook flowed along a steep bank about a metre high. Here the *Sphagnum*-belt disappeared and was replaced by a more mixed vegetation. Lowermost, at a height of about 10 cm. above the water, grew *Fossombronina*, *Haplozia crenulata*, *Alicularia scalaris*, and *Anthoceros*, then followed thick cushions of *Hylocomium squarrosum*, *Hypnum stramineum*, *Thuidium delicatulum*, *Sphagnum teres*, *S. imbricatum* and *Catharinea undulata*,

moreover, *Haplozia sphærocarpa* woven into the *Catharinea*-cushions. All the mosses had developed to an unusual height and vigour, especially *Catharinea* which occurred in a peculiar form (f. *thermophila*) and formed large cushions more than 10 cm. deep. The same vigorous moss vegetation, associated with grasses and sedges, was also found on the flat above the steep bank, as far as the influence of the warm vapours was felt.

Where the banks were low, so that the hot water partially flowed over and mixed with the cold water of the boggy ground, the usual bog or stream-bank vegetation was developed, which nearest to the outlet, in hot water of a temperature of about 25°—30°, consisted of a very slender form of *Philonotis fontana*, associated with some *Hypnum stramineum* and *Catoscopium nigratum*.

The *Hypnum*-belt mentioned above gradually merged into the usual grassland vegetation; most of the species of which (for instance *Racomitrium canescens*, *R. hypnoides*, *Philonotis*, *Mniobryum albicans* and *Hypnum uncinatum*) were also found intermixed with the thermophilous vegetation proper.

A short distance from the main group of the hot springs, on a small, flat piece of ground near the river, there are some small holes, some of which emit boiling water, and some vapours impregnated with sulphuretted hydrogen. The ground around these holes consists of a rather dry, warm (30°—40°), clayey soil, with a very sparse vegetation. *Archidium* is common everywhere; *Fossombronia* often grows around the holes, and here and there on the clayey flats *Riccia crystallina* and *Anthoceros punctatus*.

Laugaráshverir (Fig. 22) are situated in the southernmost part of Biskupstúngur, near the farm Laugarás. At the foot of the slope on which the farm is situated, and in the boggy ground below, there issue several boiling hot springs which, through several channels, unite and form a large brook which flows into the Túngulfjót. The vegetation is very much like that in Thorlákshver. Next to the water there is a belt of *Fossombronia*, *Haplozia crenulata*, *Alicularia* and *Archidium* with a ground temperature of as much as 43°; then comes the *Sphagnum*-belt which is composed of *S. subnitens* var. *coerulescens*, *S. teres*, *S. angustifolium*, *S. cymbifolium*, *S. imbricatum* and *S. inundatum* in association with *Hypnum stramineum*. The warm ground between the channels was covered with extensive mats of *Hypnum imponens*, *H. Lindbergii*, *H. stramineum*, *Hylocomium squarrosum*, *Climacium dendroides*, *Thuidium delicatu-*

lum, *Calypogeia Trichomanis* and *Scapania irrigua*. *Aulacomnium palustre* was occasionally met with on wetter ground, and *Archidium phascoides*, *Ditrichum homomallum* and, on a single spot, *Campylopus fragilis* on rather dry, clayey soil. Under the *Hyp-*



Fig. 22. Laugaráshverir. The springs are situated at the foot of a hill; along the outlet-channel and next to the water there is a narrow, dark belt of *Hepaticae* and *Archidium*, then comes a broad belt of *Sphagnum*-cushions, and outside that (the dark patch in the foreground) are *Hypnum*-carpets.

num-mats there was an almost constant temperature of 32° , and under *Archidium* as much as 46° . On the slope above one of the largest springs *Riccia sorocarpa* grew in abundance, and where steep banks were formed along the outlets grew *Hypnum*, *Thuidium* and *Catharinea undulata* f. *thermophila*; as was the case near Thorlákshver.

Further northwards near the Bruará is Sýdri Reykjahver. This consists of a large round basin from the centre of which the spring rises, bubbling up at short intervals and ejecting a considerable amount of boiling hot water which flows over the edge of the basin and gathers together into a brook which flows into the river.

On the somewhat higher and eastern side of the basin there is luxuriant grassland, while the lower western side bears a vigorous Bryophyte vegetation. Here, next to the water, grew extensive dark-green and reddish-brown mats of *Alicularia scalaris*, *Haplozia crenulata* and some *Catoscopium nigrum* in which bluish-green patches of *Fossombronia* occurred interspersed, and occasionally rosettes of *Anthoceros punctatus*. Here the temperature of the ground was 25°—27° just below the surface. Then followed a belt, about 2 metres broad, of *Sphagnum papillosum*, *S. cymbifolium* and fruiting specimens of *Polytrichum commune*, with a ground temperature of about 20°.

Lowermost on the steep bank (50—70 metres high) along the outlet grew the usual belt of *Hepaticæ* consisting of *Haplozia*, *Alicularia* and *Anthoceros*, then an abundance of *Oligotrichum hercynicum* interwoven with *Haplozia sphaerocarpa*, and uppermost along the edge large cushions of *Hypnum stramineum*, *Hylocomium squarrosum* and some *Sphagnum cymbifolium*, and here and there *Calyptopogon Trichomanis*.

In a small bog by the side of the basin, into which the hot water no doubt frequently flowed, grew, in addition to the usual bog vegetation, numerous large cushions of *Sphagnum teres* and *S. inundatum*.

The Hot Springs in Reykholtalur. Throughout the whole of Reykholtalur, on both sides of the river Reykjadalur, there occur very many hot springs, some of which discharge a great amount of water. Near the vicarage of Reykholt rise Dýnkur, Skribla, Snorralaus and other springs, which in part contain sulphuretted hydrogen. Some hundred metres more to the south, on the other side of the river, is Hagindishver, and farther down the valley are other hot springs, of which the largest are Deildatúnguhver, Snældubeinstadahver, Stúrlurreykjahver, Kleppjarnsreykir (probably Grönlund's Kleppholtsreykir) and Vellindishver; the last-mentioned is a fountain (geysir), which is situated on a small rock in the river, and is quite bare of vegetation. The

water in all these latter springs is pure and free from sulphuretted hydrogen.

Near the springs around Reykholt the Bryophyte vegetation is rather scanty, partly on account of the sulphuretted hydrogen, and partly on account of the constant disturbances caused by the traffic and the use of the hot water. *Sphagnum* is practically absent. Along the outlets of the springs liverworts grew almost exclusively. *Fossombronia* and *Blasia pusilla* were very common, the latter grew in the form of flattened rosettes. *Haplozia crenulata* and *Alicularia scalaris* were also frequent.

Around all the other springs in Reykholtalur there was a luxuriant vegetation of *Sphagna*. *S. papillosum* was especially dominant and occurred in very large cushions, often 20—25 cm. deep, but besides this many other species were found either intermixed or separately in yellow, greenish, red or brownish cushions. The following species have been found on warm ground in Reykholtalur: *Sphagnum papillosum*, *S. cymbifolium*, *S. angustifolium*, *S. rubellum*, *S. Warnstorffii* and *S. teres* were all common, *S. subnitens* (fr.), *S. acutifolium*, and *S. Dusenii* var. *falcatum* occurred only now and then.

The *Sphagnum* spp. grew partly as a belt along the outlets of the springs, partly on the boggy ground over which the hot water was flowing. Intermixed with these grew everywhere *Hypnum stramineum*, and in many places *Polytrichum commune* with ripe capsules. Near Snældubeinstadahver *Odontoschisma Sphagni* was scantily woven into tufts of *S. rubellum*.

The warm clayey flats next to the water, and especially the steep banks stretching down towards the outlets, were covered with a dense carpet of mosses and liverworts, in which the latter were usually in the majority. The bluegreen rosettes of *Anthoceros* were found almost everywhere, usually together with *Fossombronia*, *Blasia*, *Alicularia scalaris* and *Haplozia crenulata*. In such places *Archidium* also often grew in great abundance.

Grönlund records *Catoscopium nigrum* as occurring abundantly around hot springs in Reykholtalur, but he has confused it with *Archidium phascoides*. *Catoscopium* is found only exceptionally, and, as it were, accidentally on warm ground, sometimes in a somewhat divergent, slightly tomentose form (var. *Grönlundii* C. J.).

On warm boggy ground the *Sphagnum* carpet was often greatly intermixed with, or partly replaced by, a *Hypnum* vegetation to-

gether with some other Bryophyta. *Hypnum revolvens*, *H. exannulatum*, *H. stramineum*, *H. stellatum*, *Acrocladium cuspidatum*, *Scapania irrigua*, *Pellia Neesiana* and *Alicularia scalaris* were very common, *Aneura multifida* occurred here and there, especially in the *Sphagnum rubellum* cushions. Where the ground was less damp, especially on slightly inclined slopes stretching down towards the hot water, it was covered with a thick carpet of *Hypnum imponens*, *H. molluscum*, *H. stramineum*, *H. revolvens*, *Hylocomium squarrosum*, *H. parietinum*, *H. proliferum* and *Camptothecium lutescens*, in which were scattered cushions of *Sphagnum*, especially *S. rubellum* and *S. teres*. Sometimes *Preissia commutata* also could form bluish-green patches, about a metre in breadth, usually intermixed with some *Hypnum molluscum*.

Stúrlurreykjahver is situated on a slightly inclined slope stretching down towards the river Reykjadalásá. At the top, near the spring, there is the usual *Sphagnum* vegetation which, farther downwards where the ground on both sides of the outlet of the spring is rather boggy, is replaced by a greatly mixed vegetation, composed principally of *Hypnum imponens*, *Hylocomium squarrosum*, *Polytrichum gracile*, *Dicranum scoparium* var. *orthophyllum*, *Calyptogeia Trichomanis* and *Alicularia scalaris*. Alternating with the *Hypnum* carpet, extensive, dark-green mats of *Archidium* are found. The surface temperature of the ground under the *Sphagnum* carpet was, as a rule, 40°, whilst under the *Hypnum-Archidium* carpet there was an almost constant temperature of 37°. On stones in the tepid water, the temperature of which was at this spot 34°, grew large cushions of *Dicranella squarrosa*.

Kleppjarnsreykir is undoubtedly the same spring that Grönlund (1877, p. 350) calls Kleppholtsreykir. He states that at this spring the same two species of *Sphagnum* occur that are found near Túnguhver, and that near the spring and its outlet, among others, "*Distichium capillaceum*, *Mnium serratum*, *Hypnum ochraceum* and *Catoscopium nigratum*" are found. The two last-mentioned have been wrongly determined, and the two first do not at any rate belong to the species characteristic of the warm ground.

The outlet has for a tolerably long distance steep banks, about half a metre high, which are, at the foot, covered with the usual liverwort-vegetation: *Haplozia crenulata*, *Fossombronina*, *Anthoceros*, *Alicularia* and *Archidium*. The uppermost part is covered with a dense moss-carpet consisting of *Hylocomium squarrosum*, *H. proli-*

ferum, *Hypnum imponens*, *Mnium hornum*, *M. undulatum*, *M. serratum*, *Fissidens osmundoides* and *Enthostodon ericetorum*. On a stone partly inundated by the hot water, which had a temperature of about 50°, *Fissidens osmundoides*, *Blindia acuta*, *Dicranella squarrosa*, *Enthostodon ericetorum*, *Anthoceros punctatus*, *Aneura multifida* and *Scapania irrigua* grew intermixed.

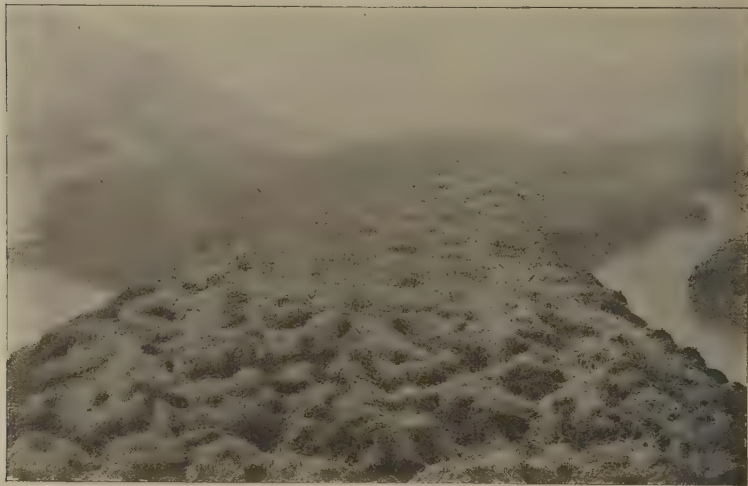


Fig. 23. Deildatúnguhver. To the left is the slope with the hot springs. The part in the middle is saturated with the hot water and covered with *Sphagnum papillosum*, *Polytrichum commune* and *Hydrocotyle*.

Deildatúnguhver (Grönlund's Túnguhver) (Fig. 23) is situated north of the river and opposite to Kleppjarnsreykir. It is mentioned by Grönlund (1877, p. 349), who states that the surface temperature of the ground at the top of the hill was 23° R, and that there *Polytrichum commune*, *Sphagnum cymbifolium*, *S. cuspidatum* and a *Campylopus* (*C. flexuosus*) — not determined with certainty — grew in the warm ground. Deildatúnguhver is one of the hot springs of Iceland which discharge the greatest amount of water, and consists of a row of holes at the foot of a hill 6—8 metres high, whence an enormous quantity of water and steam is ejected with a great noise. The masses of steam, which can be seen for miles, enshroud the surroundings of the spring with so dense a cloud that it is hardly possible to approach without getting soaked through. Below the hill the water

gathers into a broad brook which flows into the river. The whole hill, which consists of reddish clay, is warm throughout, and at the top the temperature was 36°—40° just below the surface of the ground.

On the slope stretching down towards the springs *Blasia pusilla* grew abundantly, occasionally in company with *Fossombronia Dumortieri*. The dry ground on the top of the hill was covered with large patches of *Campylopus flexuosus* and *Hypnum imponens* intermixed with scattered tufts of *Catharinea undulata* and *Oligotrichum hercynicum* and entirely interwoven with *Gymnocola inflata*. At the foot of the hill, but on the opposite side to that on which the springs lie and where the ground was damper, grew, in addition to the above-mentioned species, *Sphagnum cymbifolium* and *Polytrichum gracile*. Here some 5–6 small plants of the fern *Blechnum spicant* were also found.

The warm brook below the hill divides into several branches, which flow round some large islands saturating them with the warm water. Here *Sphagnum papillosum*, *S. angustifolium* and *Polytrichum commune* grew in enormous cushions, which were everywhere covered by the orbicular leaves of *Hydrocotyle vulgaris* and entirely enshrouded in hot vapours.

Geysir. On a low mound about one kilometre long and about $\frac{1}{2}$ a kilometre broad, situated about 100 metres above sea-level, there are a great number of hot springs (about 40) besides the well-known Great Geysir. The majority of these springs consist of a larger or smaller hole, but sometimes of a basin, several metres in diameter, in which the boiling water usually reaches to the upper edge and flows over the somewhat raised rim, or is ejected at shorter or longer intervals. The soil consists of reddish clay, or nearest to the springs — especially to Geysir — of siliceous sinter. The water in the majority of the springs smells slightly of sulphuretted hydrogen. The whole district around the springs is warm, and in many places the temperature is so high that the tenants of the neighbouring farm (Laug) bake their bread by putting the dough into a pot and burying it about 30–40 cm. below the surface of the ground.

The siliceous sinters are quite bare of vegetation. The warm clay-flats situated on a higher level are, as a rule, dry, and either bear a greatly scattered Bryophyte vegetation or are quite bare. Under the scattered, low cushions of *Ditrichum homomallum*, *Arch-*

dium and *Fossombronia* which were growing here, the thermometer showed as high a temperature as 34° on the surface of the ground. On a slightly damp flat which was covered with a low-growing, dense form of *Climacium dendroides*, the surface temperature of the ground was 43° .

In the more low-lying tracts, where the ground was rather damp, or partially inundated with hot water, there had, in several places, developed a luxuriant vegetation of phanerogams and mosses, which was, however, often much trodden down. Here, in the boggy parts, grew a low vegetation of *Carex-Viola palustris*, greatly mixed with Bryophyta, of which the following species, which grew intermixed, were observed: *Hypnum stramineum*, *H. sarmentosum*, *H. imponens*, *Hylocomium squarrosum*, *Sphagnum cymbifolium*, *Catharina undulata*, *Calyptogeia Trichomanis*, *Alicularia scalaris*, *Haplozia crenulata*, *Scapania irrigua*, *Aneura pinguis* and an undeterminable *Pohlia*. On damp clayey flats *Archidium*, *Fossombronia Dumortieri*, *Haplozia crenulata* and *Alicularia scalaris* formed low, dense mats in which *Anthoceros punctatus* occasionally occurred in small rosettes.

Below Great Geysir, *Hypnum chrysophyllum* grew on a clayey flat inundated with tepid water.

Laugarvatnshverir. By the shore of lake Laugarvatn, below the farm of the same name and along the water's edge, there is a row of springs containing boiling water saturated with sulphuretted hydrogen. The surrounding ground which consists of black basalt gravel is, owing to its exposed situation, quite bare of Bryophyte vegetation; and of higher plants only a few specimens of *Polygonum Persicaria* were found. By the northernmost of the springs only, which is situated at some distance from the lake shore, a warm, damp clayey flat was covered with a carpet of *Sphagnum cymbifolium*, *S. Girgensohnii*, *Polytrichum commune*, *Hylocomium squarrosum*, *Hypnum stramineum*, *Archidium phascoides*, *Pohlia grandiflora* ♀, *Aongstroemia longipes*, *Gymnocolea inflata*

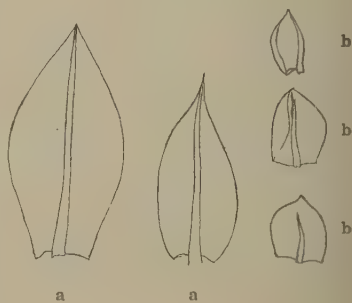


Fig. 24. *Bryum* sp. a, Older leaves developed before the plant was inundated with hot water; b, leaves from shoot developed in hot water (Geysir).

c. coles., *Haplozia sphærocarpa*, *H. crenulata*, *Alicularia scalaris* and *Scapania irrigua*.

At **Englandshverir**, some small hot springs which rise in Lundurreykjadalur, there was only opportunity for quite a short stay on the journey past. Here, on the warm ground along the outlet of the springs the following species were observed: *Sphagnum teres*, *Hypnum imponens*, *Catharinea undulata*, *Fissidenis osmundoides*, *Enthostodon ericetorum*, *Catoscopium nigratum*, *Archidium phascoides*, *Aneura pinguis*, *Pellia Neesiana* and *Fossombronina Dumortieri*.

The **Hot Springs near Reykir**. In the south-western part of Iceland, around the farms Reykir and Reykirfoss, about 45 kilometres south-east of Reykjavik, there is a very large group of hot springs which stretches towards the north and north-west, through the valleys, right up upon Hengill to a height of 400—500 metres above sea-level. To this group must also be reckoned the hot springs near Kolvidarhol and on Hellisheidi. The majority of the springs are situated around the farm Reykirfoss, and north of the latter, on both sides of the river from a height of about 50 to 90 metres above sea-level; most of them are in the neighbourhood of the river, and are in part situated directly upon the banks of the latter, several, however, lie upon the slope of Reykjafjall, up to about 100 metres above sea-level. Where the naked basalt does not protrude, the ground around the springs consists of greyish-white siliceous sinter almost bare of vegetation, and large tracts of it are warm and, so to speak, perforated like a sieve with numerous hot springs of all possible sizes. These appear in the form of (1) steaming holes (fumaroles) which range in size from quite fine pores to rather large funnels, (2) fountains (geysirs) which at short intervals eject boiling water ranging from quite a slender jet one foot in height to mighty columns of roaring water from 10 to 15 feet in height (Little Gey sir), (3) mud-pools with bubbling, bluish-grey mud which is often ejected to a distance far beyond the surroundings of the pool, and (4) boiling basins or cauldrons which may measure 6—8 metres in diameter, and either have a quiet surface or boil up at short intervals, so that the water partially flows over the edge of the basin. The steam is everywhere impregnated with sulphuretted hydrogen, with the result that the vegetation is very poor and homogeneous. The luxuriant *Sphagnum*-vegetation known from the alkaline springs does not occur near these springs. Around these steaming holes,

geysirs and mud pools the ground is usually quite bare as far as the boiling water and the mud are able to spurt.

Near the boiling basins which occur in great number and generally have a diameter of 2—4 metres, the ground forms, as a rule, a slope on the one side with an angle of 25° — 40° , whilst on the opposite side the water flows down a gentle slope which stretches as far as to the river. The ground for the first 10—20 cm. of this slope, which corresponds approximately to the different water-levels, is of a greyish-white colour and quite bare of vegetation. Then comes a belt of varying breadth formed of liverworts which, next to the water, are black or of a brownish black, above this of a reddish-brown or brownish-green, and at the top, green. This liverwort-carpet was everywhere composed of *Gymnocolea inflata*, *Haplizia crenulata*, occasionally also *Alicularia scalaris* f. *rufescens* and at the top *Cephalozia bicuspidata*. The temperature under the moss-covering was on an average 20° — 25° .

Polytrichum commune grew scattered in the liverwort carpet, from which its bluish-green tops protruded several centimetres, but frequently it also formed large growths above the liverworts, partly interwoven with the latter. Only very few phanerogams were able to grow there, usually only flowerless specimens of *Viola palustris*, the short-stemmed leaves of which rested on the liverwort carpet. Besides the above-mentioned Bryophyta several others were found on the warm clayey flats, although far more scantily. *Anthoceros punctatus*, *Fossombronia Dumortieri*, *Blasia pusilla* and *Archidium phascoides* grew here and there. In several places *Oligotrichum hercynicum* occurred in tufts a few mm. high, and in one single locality *Alicularia geoscypha* and *Aongstræmia longipes* were found in company with it. On warm ground between loose blocks of rock, at an altitude of about 260 metres, the following were found among others: *Polytrichum commune*, *Hylocomium loreum*, *Plagiothecium elegans* and *Diplophyllum albicans*.

In the neighbourhood of the farm Reykirfoss, on the western side of the river, and at the edge of the lava field, there is a rather large spring with pure water of a temperature of about 37° . Here the blocks of stone in the water were quite covered with *Pellia Neesiana*, in the tufts of which *Veronica Anagallis* had taken root.

Where the boiling water flowed over the slightly inclined slopes, it deposited greyish-white siliceous sinter, upon which grew blue-green algæ as soon as the water had cooled down to 60° — 70° . The

Bryophyta appeared first at the edge of the outlet of the spring where the temperature was 25° – 40° . The vegetation here resembled that of wet, cold ground, and was usually composed of *Philonotis fontana*, *Mnium Seligeri*, *Hypnum stramineum*, *Catoscopium nigrum*, and in a single spot of some *Sphagnum angustifolium*. On drier, warmer ground *Hypnum imponens* was found here and there in company with *Hypnum stramineum*, *Hylocomium squarrosum*, *Archidium phascoides*, etc.

Of the hot springs situated at higher levels only a few have been investigated. In the neighbourhood of Kolvidarhol, at an altitude of about 350 metres, on the warm ground around some holes whence issued vapours impregnated with sulphuretted hydrogen and where sulphur had been deposited, the following species were growing: *Gymnocolea inflata*, *Haplozia crenulata*, *Fossombronia Dumortieri*, *Aneura pinguis*, *Archidium phascoides* and *Polytrichum commune*. Here *Gymnocolea inflata* was not strictly confined to the warm ground, but appeared rather to prefer clay, as it also grew on clayey flats which had probably been warm previously, but were now quite cold.

The same species together with *Blasia pusilla* grew also in Reykjadalur (at an altitude of about 260 metres) on the damp base of a warm slope from which vapours, containing sulphuretted hydrogen, and water issued sparsely from numerous small holes. Near some mud-pools on Hellisheidi only *Gymnocolea inflata* and *Haplozia crenulata* occurred.

The **Sulphur Springs on Reykjanes** — which I myself had no opportunity of visiting — have been described by Ostenfeld (Bot. Tids., vol. 22, p. 239). They occur in two groups, near Reykjanes lighthouse and also near Krisuvík.

The Solfataras near Reykjanes lighthouse form a large group with numerous orifices of discharge, partly mud-pools, partly steaming holes, everywhere around which the ground is warm (20° – 30°). Near the outlet of the largest mud-pool, Gunna, the damp ground, which had a temperature of about 30° , was covered with *Haplozia crenulata* to which, along the margin, came several other species, viz. *Fossombronia Dumortieri*, *Archidium phascoides* (recorded by Ostenfeld as *Pohlia nutans* v. *filicaulis*), *Trichostomum littorale* and *Bryum ventricosum*, all of which, however, only occurred sparingly. Around the steaming holes grew *Riccia bifurca*, *Preissia commutata*, *Fossombronia Dumortieri*, *Archidium phascoides*,

Bryum ventricosum, *Fissidens osmundoides* and *Philonotis fontana*.

The Sulphur Springs near Krisuvík are, according to Ostenfeld, rather bare of vegetation, and he mentions only *Haplozia crenulata* as growing near a few of these. The collections contain also *Gymnocolea inflata* and *Polytrichum commune* which were gathered here by Steenstrup, so probably the same species occur on this spot as are, for instance, to be found near Kolvidarhol.

In the remaining part of Iceland the vegetation of the warm ground has hardly been investigated at all. During my stay at Mývatn in 1909 continual rain and fog prevented me from making a closer investigation of the numerous sulphur springs which occur there. The warm clayey flats were mostly quite bare, only around a single steaming hole, where the temperature of the surface was about 40°, grew *Riccia bifurca*, *Haplozia crenulata* and *Fossombronina Dumortieri*.

A moss-cushion from one of the Solfataras near Kverkfjall, (Eyafjallajökul) collected by Andr. Lundager, consisted of *Philonotis fontana* and *Riccia bifurca*.

By comparing what is known regarding the moss vegetation of warm ground, it is seen that the composition of the vegetation is dependent on the chemical nature of both the water and the escaping vapours, and also on conditions pertaining to soil.

Where the water is free from sulphuretted hydrogen, or where it, at most, contains a trace of it, the *Sphagnum* vegetation is very luxuriant, especially when the surroundings of the spring are boggy, as is the case in Biskupstúngur and near most of the springs in Reykholtdalur. The condition for the formation of a continuous Sphagnetum, in addition to a warm, damp substratum, is an abundant development of vapour, which envelops the moss-cushions in a damp, warm atmosphere. The most frequent species is *S. papillosum*, which often constitutes the bulk of the *Sphagnum* carpet, in association with *S. cymbifolium*, *S. angustifolium* and *S. teres*, frequently replaced by, or intermixed in patches with, some other species. Scattered in the *Sphagnum* carpet grew, as a rule, a very vigorous, fruiting form of *Polytrichum commune*, and usually also *Hypnum stramineum*, *Hylocomium squarrosum* or *Acrocladium cuspidatum*.

Outside the *Sphagnum*-belt there occurs, on warm, boggy ground, a moss carpet interspersed with *Carex* spp. and other flowering plants, and chiefly composed of *Hypnaceæ*, occasionally also of *Philonotis*

fontana, *Aulacomnium palustre* or of an abundance of species intermixed. The commonest of these species are: *Hypnum imponens* and *H. Lindbergii*, which are often the most abundant constituents of the carpet, *H. stramineum*, *Hylocomium squarrosum*, *Acrocladium cuspidatum*, *Thuidium delicatulum*, and numerous other bog-mosses such as *Hypnum revolvens*, *H. molluscum*, *Catocopium nigrum*, *Fissidens osmundoides*, *Scapania irrigua*, *Pellia Neesiana*, *Aneura pinguis*, etc. Especially the first six species, however, occur everywhere in abundance, and often attain an unusual size and development.

As an intermixture in this moss carpet some species, for instance *Mnium hornum*, *Catharinea undulata* and *Polytrichum gracile*, are occasionally met with which partly occur also in other localities and are partly characteristic of warm ground, and in Iceland only occur in such. To the latter group belong — in addition to *Hypnum imponens*, which is rare elsewhere — *Enthostodon ericetorum*, *Calypogeia Trichomanis*, *Aneura multifida* (found scantily in one spot on cold boggy ground) and *Odontoschisma Sphagni*. Some species develop special warm-soil forms: *Catharinea undulata* f. *thermophila* is exceedingly vigorous, as much as 10 cm. high, with long, extremely wavy, second leaves right up from the base. *Philonotis fontana* becomes thread-shaped in warm ground, with long, branchless, barely tomentose shoots (Fig. 8), *Hypnum Lindbergii* develops a similar form with almost branchless, erect stems with scattered leaves, and *Hypnum imponens* is also, as a rule, much elongated and slightly branched. Comp. further *Bryum* sp. (Fig. 24). On drier, clayey ground the *Hypnum* carpet is replaced by other species. *Archidium phascoides* is extremely common, and often forms extensive growths both near alkaline springs and near springs containing sulphuretted hydrogen. Here *Campylopus flexuosus*, *C. fragilis*, *Oligotrichum hercynicum*, *Catharinea undulata*, *Gymnocolea inflata* and several other species are also to be found.

In damp clayey soil, especially along the outlets of the hot springs, both where the water is pure and where it contains sulphuretted hydrogen in small quantities, without however depositing sulphur, a low Bryophyte carpet occurs composed of species—mostly *Hepaticæ* — the majority of which are only met with in warm soil. *Haplozia crenulata*, *Fossombronina Dumortieri* and *Oligotrichum hercynicum* are also common. *Preissia commutata* is common in Reykholtdalur, *Alicularia geoscypha* and *Aongstroemia longipes* and a few other species occur here and there.

Where the surroundings of the spring consist of siliceous sinter, as is the case with the majority of the springs of the Geysir-complex, and in Reykirdalur, all species of *Sphagnum* are absent, or are to be found only as a subordinate component, and the moss vegetation is, on the whole, scanty, and consists of the same species as are to be found on clayey soil, together with some *Hypnaceæ*, *Philonotis*, etc. on damper soil.

Near the Sulphur Springs proper the Bryophyte vegetation is extremely scanty, and the ground is often quite bare of vegetation as far as the hot vapours extend. *Sphagnum* and *Hypnaceæ* are entirely absent, whereas the majority of the *Hepaticæ* are to be found, especially *Haplozia crenulata*, *Fossombronia Dumortieri*, *Gymnocolea inflata*, *Alicularia scalaris*, *Preissia commutata* together with *Archidium phascoides*, *Polytrichum commune* and a few other mosses. *Riccia* spp. (*bifurca*, *sorocarpa* and *crystallina*) belong specially to the dry, warm ground in the neighbourhood of sulphur springs.

The following species have been found on warm ground:

1. Species which occur only on warm ground.

Riccia crystallina L. Thorlákshver.

Riccia sorocarpa Bisch. Laugaráshverir.

— *bifurca* (Hoffm.) Lindenb. Mývatn; Reykjanes; Kverkfjáll.

Anthoceros punctatus L. Common.

Fossombronia Dumortieri (Hüb.) Lindb. Everywhere.

Calypogeia Trichomanis (L.) S. F. Gray. Mývatn; Reykholtalur; Englandshverir; Sydri Reykjahver; Geysir.

Odontoschisma Sphagni (Dicks.) Dum. Reykholtalur.

Sphagnum imbricatum Hornsch. Thorlákshver; Laugaráshverir.

Sphagnum cymbifolium (Ehrh.) Hedw. Common.

Sphagnum Dusenii C. Jens. v. *falcatum* Reykholtalur.

Archidium phascoides Brid. Very common everywhere.

Entosthodon ericetorum (Bals. et de Not.) C. M. Reykholtalur; Englandshverir.

Campylopus flexuosus (L.) Brid. Reykholtalur.

Campylopus fragilis (Dicks.) Br. eur. Laugaráshverir.

Barbula fallax Hedw. var. *laevifolia* n. var. Thorlákshver.

Catharinea undulata (L.) Ehrh. f. *thermophila* Thorlákshver; Laugaráshverir.

2. Species which are mainly distributed over warm

ground and only occur as an exception in other localities.

Aneura multifida (L.) Dum. Reykholtaldalur.

Haplozia crenulata (Sm.) Dum. Near all hot springs.

Gymnocolea inflata (Huds.) Dum. Reykholtaldalur; Reykirdalur; Krisuvík.

Sphagnum papillosum Lindb. Very common.

S. angustifolium C. Jens. Common near alkaline springs.

S. inundatum Russ. Laugaráshverir; Sýdri Reykjahver.

Hypnum imponens Hedw. Common near most hot springs.

Haplozia sphaerocarpa (Hook.) Dum. and *Oligotrichum hercynicum*.

These two species have a most peculiar distribution.

Haplozia has been found near several hot springs in SW. Iceland and also on mountain heights near Isafjörður.

Oligotrichum hercynicum is common near most alkaline springs, and also near a few containing sulphuretted hydrogen. It is, moreover, common on rocky flats at an altitude of 400—500 metres, and also in NW. Iceland; but is otherwise very rare.

3. Species which are also common in other localities.

Aneura pinguis Dum. Common.

Pellia Neesiana (Gottsche) Limpr. Common.

Blasia pusilla L. Near many springs.

Preissia commutata (L.) N. v. Es. Reykholtaldalur; Reykjanes.

Alicularia scalaris (Schrad.) Corda. Very common everywhere.

— *geoscypha* de Not. Reykirdalur.

Cephalozia bicuspidata (L.) Dum. Reykirdalur.

Scapania irrigua (Nees) Dum. Frequent.

Sphagnum subnitens Russ. et Warnst. Laugaráshverir; Reykholtaldalur.

S. teres (Schimp.) Ångstr. Very common.

S. rubellum Wils. Reykholtaldalur.

S. Warnstorffii Russ. Reykholtaldalur.

S. Girgensohnii Russ. Laugarvatnshverir.

Dicranella squarrosa (Schrad.) Sch. Reykholtaldalur.

Fissidens osmundoides (Sw.) Hedw. Frequent near alkaline springs.

Blindia acuta (Huds.) Br. eur. Reykholtaldalur.

Ditrichum homomallum (Hedw.) Hampe. Geysir; Reykirdalur.

Trichostomum littorale Mitten. Reykjanes.

Catocopium nigrum (Hedw.) Brid. Frequent.

Mnium undulatum (L.) Weiss. Reykholtaldalur.

Mnium hornum L. Common near alkaline springs.

Mnium serratum Schrad. Reykholtalur.

Aulacomnium palustre (L.) Schwägr. Common, several places in abundance.

Philonotis fontana (L.) Brid. Very common, often in masses.

Catharinea undulata (L.) W. et M. Common.

Polytrichum commune L. Common.

— *gracile* Dicks. Reykholtalur.

Thuidium delicatulum (L.) Mitten. Frequent.

Hypnum molluscum Hedw. Abundant near all the hot springs in Reykholtalur.

Hypnum Lindbergii (Lindb.) Mitten. Common everywhere.

Hypnum revolvens Sw. Common near many springs, especially in Reykholtalur.

Hypnum chrysophyllum Brid. Geysir.

— *sarmentosum* Whlb. Geysir.

— *stramineum* Dicks. Very common everywhere.

— *exannulatum* Gumb. Reykholtalur.

Acrocladium cuspidatum (L.) Lindb. Common.

Climacium dendroides (L.) W. & M. In many places, plentiful near Geysir.

Hylacomium squarrosum (L.) Br. eur. Common everywhere.

— *proliferum* (L.) Lindb. Common in Reykholtalur.

— *parietinum* (L.) Lindb. In several places plentiful.

Besides the species mentioned in the above list, several other species are, however, also found as more casual intermixtures in the moss carpet, especially species from boggy soil and from grass-land, for instance *Racomitrium canescens*, *R. hypnoides* and *Hypnum uncinatum*.

Mesophilous Bryophyte Formations.

The Bryophyta, as a rule, play a less prominent part in the plant-covering of soil of a middle degree of dampness, than in that of wet soil, because in the former the higher plants find more favourable conditions of life, and the Bryophyta are consequently driven more into the background and occur only as ground vegetation between the higher plants. Several other conditions are, however, of essential importance in this connection, for instance conditions pertaining to the light, the direction of the slope and the snow-covering. Bryophyta bear shade better than do the higher

plants and consequently develop better than the latter in localities which are less favourable as regards the light, for instance, on the northern sides of clefts and in caves. In valleys southern slopes are covered with grass or other herbaceous plants, while northern slopes are moss-grown. In the narrow tuff-clefts of South Iceland the sides are often covered with a luxuriant moss carpet consisting of *Hylocomium* spp., *Thuidium*, *Polytrichum*, etc. Here the snow-covering no doubt also plays an important part, since by remaining until far into the spring, it checks the growth of the higher plants far more than it does that of the mosses.

Grassland is mostly knolly, and the mosses grow abundantly on the ground between the grasses. Here it is especially species such as *Hypnum uncinatum*, *Hylocomium squarrosum*, *Climacium dendroides*, *Polytrichum alpinum* and *Racomitrium canescens* which are the most abundant constituents of the vegetation, but in addition to these many other species occur, for instance *Catharinaea undulata*, *Timmia austriaca*, *Tortella tortuosa*, *Dicranum congestum*, *Ditrichum flexicaule*, *Distichium montanum*, *Bartramia ityphylla*, *Racomitrium hypnoides*, *Hylocomium* spp., *Hypnum Lindbergii* and *Lophozia quinquedenlata*. The composition of the vegetation varies according to the degree of dampness, therefore, we sometimes find species from boggy soil and sometimes xerophilous species of heathy soil intermixed in greater and smaller quantities.

Grass-slope and Herb-slope¹. On the herb-slope the Bryophyta are very scantily represented. On the grass-slope the bottom is covered with a more or less dense carpet of mosses and liverworts in which the chief species are *Hylocomium proliferum*, *H. parietinum*, *H. squarrosum*, *H. rugosum*, *H. loreum*, *H. triquetrum*, *Hypnum uncinatum*, *Climacium dendroides*, *Camptothecium lutescens*, *Thuidium delicatulum* (S. Icel.), *Mnium affine*, *Timmia austriaca*, *Polytrichum alpinum*, *Pogonatum urnigerum*, *Racomitrium canescens*, *R. hypnoides*, *Ditrichum flexicaule*, *Lophozia lycopodioides* and *Plagiochila asplenioides*, but besides these, many other species occur as a more casual admixture.

On a stony substratum with a thin layer of soil mosses are dominant, and phanerogams grow scattered in the moss carpet. A "moss-slope" is then developed which, as a rule, is composed of the same species as those found on the grass-slope, most frequently

¹ See footnote in Thoroddsen's Physical Geography of Iceland, ante p. 330.

Hypnum uncinatum, *Hylocomium* spp., *Rhacomitrium* spp. and *Thuidium delicatulum* (S. Icel.). These are often associated with several of the xerophilous species, such as *Dicranum scoparium*, *Frullania Tamarisci*, *Plilidium ciliare* and *Antitrichia curtipendula*, through which are formed transitional stages to the moss-heaths mentioned below. In South Iceland several of the southern species have their greatest distribution on well-sheltered, grass-covered slopes with a southern exposure, for instance *Scleropodium purum*, *Eurhynchium piliferum*, *E. Stockesii*, *Thuidium tamariscinum*, *T. Philiberti*, *T. delicatulum* and *Mnium undulatum*.

Birch coppices grow on a rather dry substratum. The wood-floor is either occupied by grassland or by heather moor, and the Bryophyte vegetation does not differ in any respect from that which occurs on a corresponding substratum outside the coppices. Most frequently it consists of *Hylocomium* spp. in association with *Hypnum uncinatum* and *Rhacomitrium* spp. (*R. canescens* and *R. hypnoides*).

Bryophyta grow only rarely and scantily on tree trunks. *Radula complanata* and *Frullania dilatata* have been found in one single spot on a tree trunk, but, as a rule, it is some ground species or other which grows a little way up on the slanting trunks. In some few places *Rhacomitrium fasciculare* has been found on tree trunks to which it had spread from neighbouring stones.

Laugardalsskógur. This coppice, which is open and of about a man's height, has its floor mostly covered with heather moor, with a thick moss carpet composed of *Hylocomium parietinum*, *H. proliferum*, *H. triquetrum*, *H. squarrosum*, *Hypnum uncinatum* and *Rhacomitrium hypnoides*, occasionally *Dicranum scoparium*, *Plilidium ciliare*, *Lophozia lycopodioides* and *L. quinquedentata* also occurred. Of quite a similar composition was the moss carpet in almost all the coppices of South and West Iceland. A few other species also belong to this community, but are more rarely met with, for instance *Bryum caespitium*, *Pohlia nutans*, *P. acuminata* and *Lophozia barbata*.

Hallormstadáskógur (East Iceland). The floor here rather varies in nature, and is sometimes covered with heather moor and sometimes with grassland or peat. In heathy soil *Hylocomium* spp. were dominant in connection with *Rhacomitrium hypnoides*, while especially *Hypnum uncinatum* grew abundantly on grassy ground. Where it was very shady *Timmia austriaca* grew abundantly on knolls.

Of other species the following were observed: *Pohlia nutans*, *P. cruda*, *Bryum caespitium*, *B. affine*, *Bartramia ityphylla*, *Polytrichum alpinum*, *P. juniperinum*, *Distichium montanum*, *Ditrichum flexicaule*, *Sclania caesia*, *Tortula subulata*, *T. ruralis*, *Dicranum scoparium*, *Plilidium ciliare*, *Lophozia lycopodioides*, *L. quinquedentata*, *Frullania Tamarisci* and *Scapania curta*.

Birch coppice in Kaldalon (NW. Iceland). The south-western slope was covered with a low-growing and very dense birch coppice with a ground vegetation of numerous flowering plants (*Geranium silvaticum*, *Bartsia alpina*, *Taraxacum*, etc.) and a Bryophyte carpet of *Hylocomium proliferum*, *H. parietinum*, *H. squarrosum* and *Hypnum uncinatum* intermixed with *Dicranum scoparium*, *D. fuscescens*, *Pogonatum urnigerum*, *Polytrichum alpinum*, *Lophozia lycopodioides*, *L. quinquedentata*, *L. Flærckeii*, *L. ventricosa*, *Cephalozia bicuspidata* and *C. pleniceps*. In open spots *Pohlia nutans* was very common, and *Polytrichum gracile* occurred frequently on knolls on the floor of the coppice.

Of a similar composition is the moss carpet of all the coppices of NW. Iceland. In several spots *Dicranum majus* and *Hylocomium triquetrum* also occurred.

Bryophyta of Soil recently laid bare. On slopes, on the sides of clefts, on soil-covered rock-ledges and, on the whole, in all places where by weathering, by land-slips or by the action of water new soil is produced, which has not yet become inhabited by higher plants, a luxuriant Bryophyte vegetation occurs, which C. Jensen (1910, p. 258) includes in a group within the mesophilous associations, under the name "Moosvereine des frischen Erdbodens". A number of species are here met with, especially of the commonly occurring mesophilous forms, but also, several species belonging to damp sandy soil and to rocks. It is especially liverworts and the acrocarpous mosses which are represented here, while the pleurocarpous mosses occur but scantily. It is a condition for the growth of mosses that there is an abundant snow-covering during winter, which affords them protection from desiccation by wind.

The composition of the moss-covering varies greatly according to the prevailing degree of humidity, and the local conditions.

In such localities as those mentioned above the following Hepaticæ occur: — *Aneura pinguis*, *Marchantia polymorpha*, *Gymnomitrium concinatum*, *Alicularia scalaris*, *A. geoscypha*, *Lophozia*

quinquedentata, *L. ventricosa*, *L. Mülleri*, *L. alpestris*, *Cephalozia bicuspidata*, *Cephalozia Hampeana*, *Blepharostoma trichophyllum*, *Anthelia julacea*, *A. Juratzkana*, *Scapania subalpina*, *S. curta*, more rarely *Preissia commutata*, *Blasia pusilla*, *Eucalyx subellipticus*, *Lophozia excisa*, *L. heterocolpos* and *Lophocolea minor*. The following are the commonest mosses: — *Dichodontium pellucidum*, *Dicranella crispa*, *Distichium montanum*, *Didymodon rubellus*, *Tortula subulata*, *Desmatodon latifolius*, *Tortella tortuosa*, *T. fragilis*, *Schistidium apocarpum*, *S. gracile*, *Encalypta ciliata*, *E. rhabdocarpa*, the majority of the species of *Bryum*, *Leptobryum pyriforme*, *Pohlia commutata*, *P. cruda*, *Mniobryum albicans*, *Mnium punctatum*, *Bartramia ityphylla*, *Philonotis tomentella*, *Timmia austriaca*, *Pogonatum urnigerum*, *Myurella julacea*, *M. tenerrima*, *Brachythecium reflexum*, *Plagiothecium Roesenianum*, *Hypnum hamulosum*, *H. callichroum*, *H. uncinatum*, *Hylocomium loreum*. Some rare species, for instance *Eurhynchium strigosum* var. *præcox*, *Heterocladium squarrosulum*, *Distichium inclinatulum* and *Weisia viridula* are found especially in such localities as those mentioned above.

Xerophilous Bryophyte Associations.

Heaths.

The heath formation is extensively distributed about Iceland. It occurs especially on dry slopes, and hardly ascends higher than about 300–400 metres above sea-level, where it is succeeded by the rocky-flat association.

Heather-moor (H. Jónsson, 1900, p. 69). The chief heath-forming plants are *Empetrum nigrum*, *Vaccinium uliginosum*, *V. Myrtillus*, *Arctostaphylos uva ursi*, *Betula nana* and, especially in E. Iceland, *Calluna vulgaris*. Mosses and liverworts often grow abundantly on the ground. The Bryophyte carpet is chiefly composed of *Hylocomium* spp. (especially *H. proliferum* and *H. parietinum*), *Racomitrium hypnoides*, *R. canescens* and *Hypnum uncinatum*, but *Dicranum* spp. (*D. scoparium*, *D. fuscescens* and others), *Lophozia* spp. *Ptilidium ciliare*, *Frullania Tamarisci* and several other species often occur in abundance. As examples will best show the composition of this vegetation, the following are given: —

In North-west Iceland heath-vegetation is extensively distributed, especially around Dýrafjörður and Isafjörður. Here the heath-forming plants are mostly *Vaccinium Myrtillus*, *V. uliginosum*, *Empetrum nigrum* and occasionally *Betula nana*.

On heathy ground in Gnupdalur near Dýrafjörður a rather scattered Bryophyte vegetation was found, composed of *Hylocomium proliferum*, *H. parietinum*, *Hypnum uncinatum*, *Dicranum scoparium*, *D. molle*, *D. fuscescens*, *D. Starckeii*, *Conostomum boreale*, *Lophozia Flörckei*, *L. lycopodioides*, *L. Kunzeana*, *L. ventricosa* and



Fig. 25. Grunnavik near Jökulsfjörður in NW. Iceland. Stony slope. The low-lying parts are boggy, the somewhat higher ridges are covered with heath vegetation (*Empetrum*, *Vaccinium*, *Dicranum* spp., etc.), whilst the stony ridges situated highest (in the background) are bare of vegetation.

L. alpestris. The *Dicranum* spp. formed thick, extensive cushions, and the *Lophozia* spp. grew woven into these cushions.

Grunnavik near Jökulsfjörður (Fig. 25). Up to a height of 100—200 metres the mountain slopes were partly covered with heather-moor and partly with bog-vegetation or moss-bogs. The stony ridges, situated higher up, which had been formed by stones sliding down from the mountain above, were covered with heath, while the intervening depressions were boggy, and there along the channels, where the water formed streamlets or issued as springs, the usual "Dy" vegetation consisting of *Mniobryum albicans*, *Philonotis*, etc., had developed.

The Bryophyte carpet of the heath was composed of *Hylocomium parietinum*, *H. proliferum*, *Hypnum uncinatum*, *Rhacomitrium hypnoides*, *Dicranum scoparium*, *D. fuscescens*, *D. molle*, *Ptilidium ciliare*, *Lophozia Flærckei*, *L. lycopodioides*, *L. ventricosa*, *Cephalozia bicuspidata*, *C. pleniceps* and scattered cushions of *Sphagnum Gir-*



Fig. 26. Knolly moor of *Betula nana* intermixed with *Salix lanata* and *Salix phylicifolia*. Ground vegetation: *Empetrum*, *Arctostaphylos uva ursi*, *Anthoxanthum odoratum* and *Polygonum viviparum*.

gensohnii. The *Dicranum* spp. especially *D. scoparium* often formed continuous carpets, which appears to correspond with the "Dicranum heaths" described by C. Jensen, 1910, p. 262.

Knolly *Betula nana* Heath near Ljosavatn (Fig. 26). In addition to *Betula nana*, which formed the bulk of the vegetation, there occurred scattered shrubs of *Salix phylicifolia*, *S. glauca* and numerous grasses and flowering plants. Mosses and liverworts grew abundantly on the knolls and on the ground between them. The following species were observed: *Hypnum uncinatum*, *Rhacomitrium canescens*, *R. hypnoides* (all in abundance), *Hylocomium proliferum*, *H. rugosum*, *H. squarrosum*, *Camptothecium nitens*, *Heterocladium squarrosulum*, *Brachythecium erythrorrhizon*, *Polytrichum juniperinum*, *Timmia austriaca*, *Conostomum boreale*, *Pohlia cruda*, *Bartramia ityphylla*, *Tortella tortuosa*, *Dicranum congestum*, *Ditrichum*

flexicaule, *Lophozia lycopodioides*, *L. Kunzeana* and *Plagiochila asplenioides*.

The Moss Heath. On dry stony tracts there often occurs a continuous growth of mosses, in which higher plants grow scattered without being able to give character to the vegetation. In heather-moors mosses often form a continuous carpet, and then all transitions between typical heather-moor and moss-heaths are found. By the decay of the mosses a humus-layer is gradually formed, and the moss-heath is thus the pioneer of other associations such as heather-moors, coppices and grassland (H. Jónsson, 1905, p. 41).

The moss heath occurs most frequently as a *Racomitrium*-heath (*Grimmia*-heath, H. J., 1895, p. 70; 1900, pp. 68 and 85; 1905, p. 40). It is found in the low land — where it is typically developed, especially in the lava fields, which are often entirely covered by it — as well as on mountain slopes, and in the Alpine region as far upwards as 600—700 metres above sea-level (Fig. 27). It also occurs in patches in other formations, for instance in grassland, where it is usually developed on the top of the knolls. *Racomitrium hypnoides* is the dominant species, and is often the only one found over considerable tracts; it forms a uniformly grey carpet, as much as a foot deep. There is only a very small intermixture of other Bryophyta. The most frequent are *Racomitrium canescens*, *Hylocomium proliferum*, *H. parietinum*, *Dicranum scoparium*, *Ptilidium ciliare*, *Frullania Tamarisci*, rarer are *Lophozia lycopodioides*, *L. barbata*, and other species. The *Racomitrium* heath is extensively distributed in many places on the taluses of fallen blocks and débris (Urd), and there — in case conditions are favourable — by the mosses decaying and forming humus, it quickly passes into other associations, especially into grass-slopes and herb-slopes.

The *Racomitrium canescens* heath is developed on a somewhat damper substratum than is the *R. hypnoides* heath, and is met with, for instance, in patches in depressions in the latter, where it is immediately distinguished by its light greyish-green colour, which differs distinctly from the whitish-grey colour of its surroundings. Here it must frequently share the locality with *Hypnum uncinatum* and is often greatly intermixed with other Bryophyta, for instance *Polytrichum alpinum*, *Hylocomium* spp., *Lophozia lycopodioides* and *L. quinquedentata*, and several other species. As an example of such a *Racomitrium canescens* heath may be mentioned a slightly inclined gravelly flat near Holt in South Iceland, about 400 me-

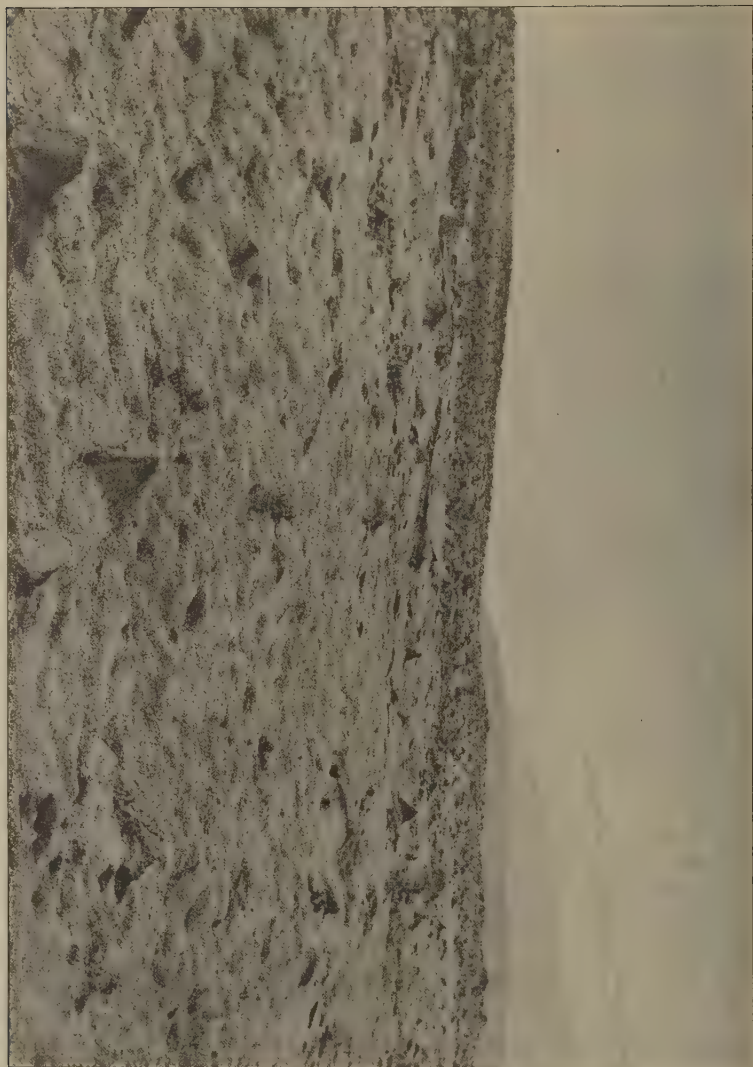


FIG. 27. *Rhacomitrium hygroides* heath near Möðruvellir (Ísja), at an altitude of about 500 metres.

tres above sea-level, which was covered with a continuous carpet of *R. canescens*, in which *Hylocomium parietinum*, *Dicranum Starckeii*, *Conostomum boreale*, *Lophozia alpestris* and *L. lycopodioides* occurred scantily interspersed (Fig. 28).



Fig. 28. *Racomitrium canescens* heath near Holt in South Iceland. In the background is seen one of the deep clefts with vertical sides, so common in this district.

Near Hof in SE. Iceland there was a horizontal, somewhat damp gravelly flat covered with a continuous moss-carpet, of which the chief species were *Racomitrium canescens* and *Hylocomium proliferum*, abundantly mixed with *Hylocomium parietinum*, *H. rugosum*, *H. squarrosum* and *Hypnum uncinatum*. Spread about in the moss carpet there grew *Dicranum scoparium*, *D. congestum*, *Ditrichum flexicaule*, *Tortella tortuosa*, *Polytrichum juniperinum*, *P. alpinum* and *Aulacomnium turgidum*. *Conostomum boreale* was common and occurred in small, compact tufts, usually interwoven with *Lophozia ventricosa*, *Gymnomitrium concinnatum*, *Anthelia* and species of *Cephalozia*, and on prominent knolls of earth *Diphyscium sessile* in association with *Gymnomitrium concinnatum* formed compact blackish-brown coverings. *Aulacomnium turgidum* occurred abundantly in several spots, more or less intermixed with *Hylocomium squarrosum*, *Hypnum uncinatum* and *Racomitrium canescens*, and formed carpets. Spread about in the moss carpet grew numerous

Juncus and *Carex* tufts, and this formation must most nearly be termed a transitional form between moss-heath and meadow-land. On the whole, *Racomitrium canescens* thrives best in Iceland on somewhat damp ground, under quite similar conditions as *Aulacomnium turgidum*.

The Mixed Moss-heath (*Hylocomium-Racomitrium* heath) occurs especially on slightly inclined gravelly flats, under similar conditions as the heather moor, and is, as a rule, a pioneer for the latter. It may, however, also develop into a grass or herb slope, where the ground is wetter. The chief species of this moss carpet are *Racomitrium canescens*, *R. hypnoides* and species of *Hylocomium*, but as a rule many other species are found intermixed with these.

In a moss-heath near Möðruvellir (Esja), on a slightly inclined gravelly flat, at an altitude of about 100 metres, the chief species of the Bryophyte carpet were *Hylocomium proliferum*, *Racomitrium hypnoides*, *R. canescens* and *Hypnum uncinatum*; more scantily occurred: *Hylocomium loreum*, *H. squarrosum*, *Climacium dendroides*, *Antitrichia curtipendula*, *Brachythecium albicans*, *Polytrichum alpinum*, *P. urnigerum*, *Timmia austriaca*, *Pohlia cruda*, *Ditrichum flexicaule*, *Bartramia ityphylla*, *Distichium montanum*, *Ptilidium ciliare*, *Frullania Tamarisci*, *Lophozia lycopodioides*, *L. quinquedentata* and *L. quadriloba*. Scattered in the Bryophyte carpet grew a few flowering plants such as *Anthoxanthum* and *Galium verum*, and this moss-heath will undoubtedly develop into grassland.

On a flat interspersed with stones at an altitude of about 400 metres the Bryophyte carpet was composed of *Racomitrium hypnoides* abundantly mixed with *R. canescens*, *Hylocomium parietinum*, *Hypnum uncinatum* and *Dicranum Starckeii*. As an intermixture in the Bryophyte carpet occurred: *Timmia austriaca*, *Pohlia commutata*, *Distichium montanum*, *Lophozia quinquedentata*, *L. quadriloba*, *L. alpestris*, *Plagiochila asplenioides*, *Blepharostoma trichophyllum*, *Anthelia Juratzkana*, *Alicularia scalaris*, *Cephalozia pleni-ceps* and *C. bicuspidata*. Flowering plants were almost entirely absent.

On prominent knolls of earth occurring on heathland and grassland, on dry ledges and slopes, a very peculiar Bryophyte covering is often found: low, very compact cushions of *Diphyscium sessile* in connection with several liverworts, especially *Gymnomitrium concinnatum*, are found covering the soil with a very dense

brownish-black carpet. *Conostomum boreale* also — usually interwoven with liverworts such as *Gymnomitrium concinnum*, *Lophozia ventricosa*, *Pleuroclada albescens* and species of *Cephalozia* — forms exceedingly compact cushions on dry, stony ground. Both these species grow in particularly exposed localities, where the snow-covering is absent during winter, but their compact tufts, densely covered with tomentum to an unusual degree, protect them from being destroyed by strong winds. *Diphyscium* forms quite low (only one cm. high), but rather wide tufts, while *Conostomum* forms tufts a few cm. in diameter, but often more than 10 cm. in height. In the latter case the basal portion of the tuft is securely wedged into the gravelly substratum and attached to the stones with numerous rhizoids. *Diphyscium* is found at all levels, while *Conostomum* is most widely distributed on the rocky flats, but in the low land occurs only somewhat scantily in the heath formation.

The Bryophyte Vegetation of the Rocks.

The rock vegetation includes formations of very various composition, with extremely different demands as regards light, moisture, etc. The substratum may consist of solid rock, for instance rock-faces, flats or large blocks, or it may consist of detached stones of various sizes, as on gravelly and stony slopes and on taluses. The distribution of the water is very unequal, since a quite dry part with decidedly xerophilous species may be met with next to a part where the water flows over the rock, and provides conditions for the growth of hygrophilous species.

The chemical and physical nature of the substratum exercises great influence upon the composition of the Bryophyte covering. On tuff and breccia the vegetation is far more luxuriant than on basalt, and the reason for this is partly because the uneven surface of the tuff affords better habitats for the plants, partly because the water penetrates into the tuff comparatively easily, and afterwards reappears through the fissures and porose parts of the rock-surface so that these are, as a rule, rather damp. The greater or smaller amount of lime present is also of importance for the frequency of many species. The direction of the exposure and the conditions pertaining to shelter play a great part with regard to the Bryophyte vegetation. Species growing on exposed rock-faces and flats must be able to endure complete desiccation by the sun during the summer, and by strong winds during the winter, while

the Bryophytes of the clefts and Urds live in a comparatively humid atmosphere and are protected by the snow-covering during the winter. The conditions pertaining to light are also of importance with regard to the composition of the Bryophyte vegetation. On the ground between the stones of the talus, grow other species than those to be found upon the stones. Caves and dark clefts contain species which belong specially to these localities, and the vegetation on vertical surfaces or slopes with a southern exposure is different to that found on the same kind of ground with a northern exposure.

Owing to the extremely different conditions to which plants are exposed when growing on rocks, all kinds of associations are met with there, from decidedly xerophilous to hygrophilous, light-forms, and species which thrive best in dark caves. The rocky substratum may be compared to a mosaic pavement, in which each particular piece of homogeneous conditions is exceedingly small.

The mosses grow partly on the rock itself (lithophytes) and partly in soil which has accumulated in fissures and depressions, or on ledges (chomophytes). The boundary line between these two groups has, however, been effaced to a great extent as many of the lithophytes proper also occasionally grow on gravel or even on soil, and it is not always possible to decide whether a moss-cushion has originally developed on humus-covered rock, or has itself formed humus by a process of decay. Especially on mountain heights the two groups merge one into the other, as species such as *Andreæa petrophila*, *Dicranoweisia crispula*, *Rhacomitrium fasciculare* and *R. sudeticum*, which in low-lying regions are decidedly lithophytes, descend to the ground on mountain heights and often form extensive growths on rocky flats. The following species may be referred to the lithophytes proper (those marked * are common):

Species belonging to Coastal Rocks.

**Ulota phyllantha*

**Schistidium maritimum*

Water Lithophytes.

**Schistidium rivulare*

**Fontinalis longifolia*

**Fontinalis antipyretica*

**Rhynchostegium rusciforme*

— *androgyna*

**Hypnum ochraceum*

— *thulensis*

— *alpinum*

— *islandica*

— *alpestre*

The remaining Lithophytes.

* <i>Metzgeria furcata</i>	* <i>Rhacomitrium fasciculare</i>
* <i>Radula complanata</i>	" — <i>aciculare</i>
<i>Gymnomitrium coralloides</i>	<i>Hedwigia albicans</i>
* <i>Madotheca Cordæana</i>	* <i>Orthotrichum rupestre</i>
<i>Frullania fragilifolia</i>	— <i>anomalum</i>
* <i>Andreæa petrophila</i>	— <i>saxatile</i>
* <i>Anœctangium compactum</i>	— <i>cupulatum</i>
<i>Weisia crispata</i>	— <i>Sturmii</i>
* <i>Dicranoweisia crispula</i>	— <i>Killiasii</i>
* <i>Blindia acuta</i>	— <i>Blyttii</i>
<i>Bryoxiphium norvegicum</i>	— <i>lævígatum</i>
<i>Tortula obtusifolia</i>	<i>Leucodon sciuroides</i>
— <i>muralis</i>	<i>Neckera complanata</i>
<i>Schistidium confertum</i>	<i>Leskea nervosa</i>
<i>Grimmia commutata</i>	* <i>Pterigynandrum filiforme</i>
— <i>alpestris</i>	<i>Lescuræa patens</i>
— <i>Doniana</i>	<i>Isothecium myurum</i>
— <i>ovata</i>	— <i>tenuinerve</i>
— <i>incurva</i>	* <i>Homalothecium sericeum</i>
— <i>patens</i>	<i>Thamnium alopecurum</i>
— <i>funalis</i>	<i>Hypnum Bambergeri</i>
* — <i>torquata</i>	* — <i>revolutum</i>
* <i>Rhacomitrium sudeticum</i>	* — <i>cupressiforme</i>
* — <i>heterostichum</i>	

In addition to the species mentioned above there are a great number of other species which are of equal frequency on bare rocks and on humus-covered rocks. To this group belong for instance *Haplozia atrovirens*, *Diplophyllum albicans*, *Amphidium Mougeotti*, *Hymenostylium curvirostre*, *Schistidium* spp. and *Hypnum hamulosum*.

To the chomophytes may be reckoned a numerous group of species which partly contain the chomophytes proper, i. e. species which properly speaking belong to humus-covered rock-ledges or to clefts, and partly a great number of species which are as frequently met with in other formations. The following species may be regarded as belonging to the chomophytes proper: —

<i>Reboulia hemisphærica</i>	* <i>Haplozia pumila</i>
<i>Sauteria alpina</i>	<i>Lophozia heterocolpos</i>
<i>Fimbriaria pilosa</i>	<i>Tortula mucronifolia</i>
<i>Fegatella conica</i>	* <i>Encalypta rhabdocarpa</i>
<i>Preissia commutata</i>	* — <i>ciliata</i>
<i>Haplozia riparia</i>	* <i>Amphidium lapponicum</i>
* — <i>atrovirens</i>	<i>Hymenostylium curvirostre</i>

<i>Sælania cæsia</i>	* <i>Orthothecium chryseum</i>
<i>Anomobryum filiforme</i>	— <i>intricatum</i>
* <i>Plagiobryum Zierii</i>	* <i>Eurhynchium strigosum</i>
<i>Bryum œneum</i>	— <i>Swartzii</i>
— <i>pallescens</i>	* <i>Plagiothecium pulchellum</i>
— <i>capillare</i>	— <i>depressum</i>
* <i>Mnium orthorrhynchum</i>	— <i>Rœseanum</i>
— <i>serratum</i>	* <i>Amblystegium Sprucei</i>
— <i>stellare</i>	<i>Hypnum hamulosum</i>

Among the species met with here, which however cannot be reckoned to the chomophytes proper, the following are the most frequent: *Bartramia iltyphylla*, *Pohlia cruda*, *Bryum inclinatum*, *B. ventricosum*, *Oncophorus virens*, *O. Wahlenbergii*, *Didymodon rubellus*, *Distichium montanum*, *Schistidium apocarpum*, *S. gracile*, *Ditrichum flexicaule*, *Philonotis tomentella*, *Marchantia polymorpha*, *Lophozia* spp., *Scapania curta*, *S. subalpina* and *Blepharostoma trichophyllum*.

Stony and Gravelly Slopes. The Bryophyte vegetation is, as a rule, rather poor in species, and not very characteristic. *Rhacomitrium* heaths are common where the slope is not too steep, but stony and gravelly slopes are often almost bare of vegetation, only here and there occur some cushions of *Dicranoweisia crispula* and species of *Rhacomitrium*.

A Stony Slope near Grunnavik in NW. Iceland consisted of large blocks at the foot, and in the upper and steeper part of smaller stones. Vegetation was absent at the top, but increased in abundance lower down as the ground gradually become more level, and the conditions thereby became more stable. Scattered among the stones grew plants of the rocky flat, for instance *Salix herbacea*, *Papaver radiculatum*, *Oxyria digyna*, *Sibbaldia procumbens* and in the shelter afforded by larger stones *Athyrium alpestre*, *Alchemilla alpina*, etc. Upon the stones grew *Rhacomitrium hypnoides*, *R. fasciculare* and *Dicranoweisia crispula* and on the ground between the stones *Brachythecium reflexum*, *Hypnum uncinatum*, *Lescuræa patens*, *L. filamentosa*, *Hylocomium squarrosum*, *Polytrichum alpinum*, *Dicranum fuscescens*, *Lophozia ventricosa*, *L. lycopodioides* and *Anthelia julacea*.

Stony Slope near Berufjördur. On the steep somewhat damp slope there grew *Rhacomitrium fasciculare*, *Schistidium gracile*, *Dicranoweisia crispula*, *Lescuræa decipiens*, *Heterocladium squarrosum* and *Timmia austriaca*.

Talus of fallen blocks and débris (Urd). The conditions for the development of plants is far more favourable here than on the stony slope, which is constantly exposed to disturbances through the down-sliding of stones and earth. The most xerophilous species, viz. species of *Racomitrium* and *Grimmia*, *Dicranoweisia crispula*, *Orthotrichum rupestre* and *Hypnum revolutum* grow on the stones, while on the ground between the stones there are favourable conditions for a number of species which have greater requirements with regard to shelter, moisture and shade. The Urd is therefore very rich in species, since lithophilous species are found there on the blocks, and species, which grow on the ground, occur between the stones, and Bryophytes belonging to heathland and grassland, are found on the soil-covered stones and ledges.

In order to show how heterogeneous the composition of the Bryophyte vegetation may be, the Urd in Heljusdalur on Vestmannaey may serve as an example. The valley is almost semicircular in shape, and open towards the south, and in consequence of this favourable situation combined with the comparatively mild, damp climate of the island, a considerable number of southern species are found there, while species such as *Ulota maritima* and *Schistidium maritimum* betoken the proximity of the sea. The rocks around the valley are inhabited by numerous sea-fowls, and they often rest on the blocks of the Urd, and on these spots, manured by the birds, it is species of *Bryum* (*B. argenteum* and *B. capillare*) which particularly make their appearance.

The fallen blocks are everywhere covered with cushions of mosses and liverworts. The commonest species are *Schistidium apocarpum*, *Ulota maritima*, *Hypnum cupressiforme*, *H. uncinatum*, *Orthotrichum rupestre* and *Ceratodon purpureus*. The following species were also observed on the blocks: *Radula complanata*, *Madrothea Cordæana*, *Plagiochila asplenioides*, *Cephaloziella Hampeana*, *Didymodon rubellus*, **Barbula cylindrica*, *Tortella tortuosa*, *T. fragilis*, *Tortula subulata*, **T. mucronifolia*, *Distichium montanum*, **Orthotrichum anomalum*, *Encalypta ciliata*, *E. rhabdocarpa*, *Pohlia cruda*, *Bryum capillare*, *B. elegans*, *B. inclinatum*, *B. orneum*, *Mnium serratum*, *M. stellare*, *M. orthorrhynchum*, *Myurella julacea*, *Orthothecium intricatum*, **Isothecium myurum*, *Homalothecium sericeum*, *Amblystegium Sprucei*, **A. serpens*, *Hypnum hamulosum* and *H. revolutum*. In the caves formed among the stones, into which the light penetrated but scantily, the walls were covered with light-green shining mats

of **Plagiothecium depressum*, the ground between the blocks was covered with a thick, dark-green carpet of *Hypnum uncinatum*, *Hylocomium squarrosus*, *Brachythecium salebrosum*, **Eurhynchium Stockesii*, *Plagiothecium Roeseanum*, **Thuidium tamariscinum*, *T. abietinum*, **Mnium undulatum*, *Ditrichum flexicaule*, *Dichodontium pellucidum*, **Lophocolea cuspidata*, **L. minor* and *Lophozia quinque-dentata*. On the soil-covered grassy ledges and slopes, between the stones, grew *Brachythecium albicans*, *B. salebrosum* (in masses), *Climacium dendroides* (in abundance), *Camptothecium lutescens*, *Hylocomium proliferum*, *H. parietinum* (sparingly) and *Mnium affine* (in abundance).

All the species marked * are southern forms the majority of which have only been found in South Iceland. On the whole, the Urd affords favourable habitats for many species which do not thrive in more exposed localities.

On a dry Urd consisting of large blocks of basalt, near Holt, in South Iceland, the following species were growing: — *Rhacomitrium fasciculare*, *R. heterostichum*, *R. hypnoides*, *Grimmia Doniana*, *Schistidium apocarpum*, *Andreæa petrophila*, *Antitrichia curtispindula*, *Hypnum uncinatum*, *Hylocomium loreum*, *H. proliferum*, *H. parietinum* and *Frullania Tamarisci*.

Almost the same species are found on larger detached blocks. On blocks of lava round about Reykjavik there grew particularly *Rhacomitrium heterostichum*, *R. fasciculare*, *Andreæa petrophila*, *Schistidium apocarpum*, *Grimmia Doniana* and *Dicranoweisia crispula*.

On larger stones in the home-field (Tunet) near Vallanes (East Iceland) there grew *Pterigynandrum filiforme*, *Hypnum revolutum*, *Tortula ruralis* and *Encalypta rhabdocarpa*. Some large blocks near Hafursholt in South Iceland were quite overgrown with *Grimmia alpestris*. On some large blocks of basalt near Seljaland there grew *Grimmia Doniana*, *Rhacomitrium fasciculare*, *R. hypnoides*, *R. sudeticum*, *Dicranoweisia crispula* and *Gymnomitrium coralloides*.

The Vertical Rock-belts. Owing to the division into layers peculiar to the basalt, the mountain sides consist of numerous vertical scarps of varying height, alternating with slopes formed by fallen blocks and debris. As a rule, the first 100—200 metres of the mountain form a slope which is only slightly inclined at the bottom and becomes steeper higher up, and where only here and there small portions of the primitive rock protrude. This slope is limited by a precipitous rock-face of very varying height, sometimes ris-

ing to a height of several hundred metres, right up to the plateau on the mountain top, but usually divided into numerous steps, consisting of shelves or ledges of varying breadth. The rock-face is here and there intersected by deep fissures and clefts, excavated by the downward-flowing water, which partly drains away in

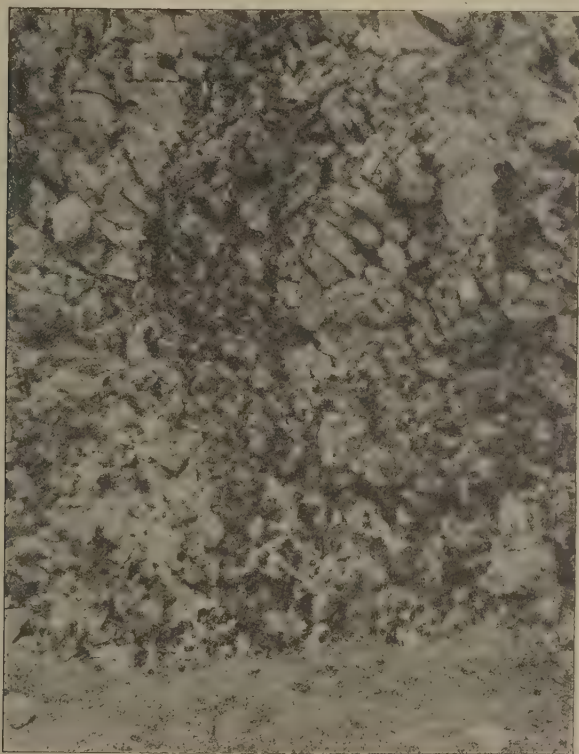


Fig. 29. Face of basalt rock (E. Iceland). Everywhere in the crevices small, black, moss-cushions (*Andreaea*, *Dicranoweisia crispula* and *Grimmia* spp.).

these channels, partly spreads over the ledges and from thence flows down the rock-faces or penetrates into the crevices of the rock, and then reappears once more further down. Consequently, the conditions pertaining to moisture vary greatly, and therefore the moss-covering also. As some examples will best show the composition of the latter, the following are given: —

1. Esja, low damp rock-face just above the slope:

Philonotis tomentella, *Mnium punctatum*, *M. orthorrhynchum*, *Amphidium Mougeotii*, *A. lapponicum*, *Anæctangium compactum*, *Didymodon rubellus* and *Schistidium gracile* grew abundantly in extensive cushions. *Lescuræa filamentosa* was found abundantly at the basal part of the rock-face. *Pohlia cruda*, *Bartramia ityphylla*, *Plagiothecium pulchellum*, *Myurella julacea*, *M. tenerrima*, *Radula complanata*, *Haplozia atrovirens* and *Marchantia polymorpha* grew partly in small tufts, partly intermixed with other species in the tufts formed by them.

2. Botnsdalur, Hvalfjörður: damp rock-face. The base of the rock-face, up to a height of about a few metres, was covered with extensive cushions of *Hypnum cupressiforme*, *H. molluscum*, *Brachythecium glareosum*, *Orthothecium chryseum*, *Philonotis tomentella* and *Distichium montanum*. Where the rock-face was wet with the downward-oozing water, large patches of it were covered with *Anomobryum concinnum*. Partly in the crevices of the rock-face, partly scattered in the tufts there occurred *Amblystegium Sprucei*, *Bryum pallescens*, *B. inclinatum*, *Lophozia quinquedentata*, *L. Mülleri*, *Blepharostoma trichophyllum* and *Aneura pinguis*.

3. Berufjörður, rock-face, where the water was oozing down from the ledge above: *Hypnum alpestre*, *Orthothecium chryseum*, *Blindia acuta*, *Onchophorus Wahlenbergii*, *Plagiopus (Ederi)*, *Philonotis fontana*, *Distichium montanum*, *Myurella julacea*, *M. tenerrima*, *Scapania subalpina*, *Lophozia quinquedentata*, *Haplozia atrovirens* and *H. cordifolia*.

4. Seydisfjörður, dry rock face with a northern exposure. On the dry rock face itself there grew: *Pterigynandrum filiforme*, *Homalothecium sericeum*, *Grimmia fanalis*, *G. torquata*, *Hypnum revolutum* and *Orthotrichum rupestre*. The basal part of the rock-face was much weathered, presenting numerous crevices and small ledges. There grew: *Hypnum revolutum*, *H. filicinum*, *Orthothecium chryseum*, *Plagiothecium pulchellum*, *P. Roeseanum*, *Myurella julacea*, *M. tenerrima*, *Amphidium Mougeotii*, *Mnium orthorrhynchum*, *Bartramia ityphylla*, *Pohlia cruda*, *Plagiobryum Zierii*, *Meesea trichoides*, *Orthotrichum Blyttii*, *Distichium montanum*, *Ditrichum flexicaule*, *Fissidens osmundoides*, *Schistidium confertum*, *Didymodon rubellus*, *Metzgeria furcata*, *Blepharostoma trichophyllum* and *Odontoschisma elongatum*.

5. Akureyri, dry rock-face, 350 metres above sea-level. The rock-face was covered with extensive mats of *Homalothecium sericeum* and *Pterigynandrum filiforme* mixed with cus-

tions of *Grimmia funalis*, *Hypnum revolutum*, *Rhacomitrium heterostichum* and *Orthotrichum rupestre*. On the basal and somewhat damper portion of the rock-face there grew *Gymnostomum rupestre*, *Philonotis tomentella*, *Orthothecium chryseum*, *Hypnum uncinatum*, *Distichium montanum*, *Ditrichum flexicaule*, *Amphidium lapponicum*, *Pohlia cruda*, *Bartramia ityphylla*, *Ceratodon purpureus*, *Tortella tor-*

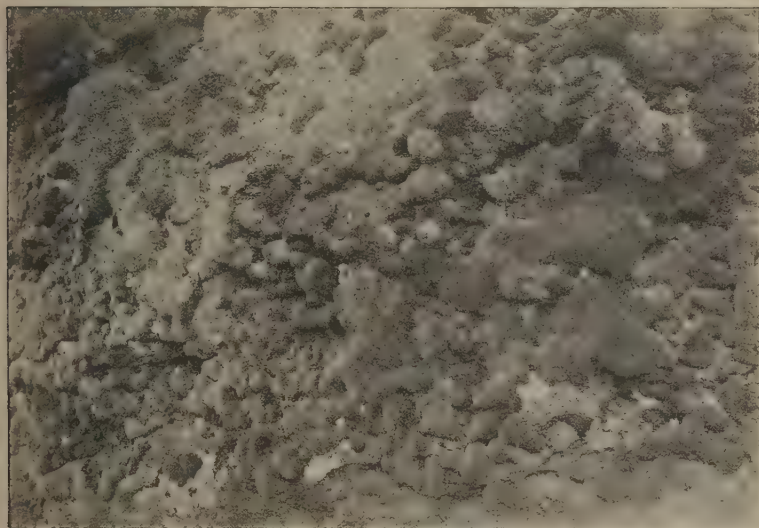


Fig. 30. *Grimmia torquata* on one of the sides of Flokastadagil.

tuosa, *Lophozia quinquedentata*, *L. quadriloba* and everywhere on the ledges large cushions of fruiting *Tortula ruralis*.

The two last quoted examples are typical of the vegetation of dry rock-faces. *Homalothecium sericeum* occurs there almost always, and is often dominant on exposed rock-faces as far upwards as 400—500 metres above sea-level, *Pterigynandrum* is also extremely common, especially in the low land. *Grimmia funalis* is rarely absent and often forms very large and deep, fruiting tufts, and especially in South Iceland *G. torquata* is extremely common and often covers large portions of the rock-faces with its irregularly-rounded cushions (Fig. 30).

6. Low, much weathered and fissured basalt rocks near Hof in SE. Iceland. On the top of the rocks it was espe-

cially *Racomitrium hypnoides* which grew abundantly on débris produced by disintegration. On the rocks there grew *Hypnum cupressiforme*, *H. revolutum*, *H. imponens*, *Plerigynandrum filiforme*, *Leskea nervosa*, *Racomitrium fasciculare*, *R. heterostichum*, *Grimmia funalis*, *G. Doniana*, *Schistidium apocarpum*, *S. confertum*, *Dicranoweisia crispula*, *Andreæa petrophila*, *Orthotrichum rupestre*, *O. Sturmii*, *Gymnomitrium coralloides*, *Frullania Tamarisci*, *Radula complanata*, *Metzgeria furcata* and at the base of the rock, *Madotheca Cordæana*. A southern rock-face was covered with *Leucodon sciuroides* var. *morensis*. In clefts and crevices and on soil-covered ledges there grew *Mnium orthorrhynchum*, *M. stellare*, *Pohlia cruda*, *Encalypta ciliata*, *E. rhabdocarpa*, *Bartramia ityphylla*, *Dicranum Andersonii*, *Distichium montanum*, *Ditrichum flexicaule*, *Didymodon rubellus*, *Amphidium lapponicum*, *Plagiochila asplenioides*, *Marsupella Funckii* and *Lophozia alpestris*.

The locality just described comes nearest to that known in Iceland as "Holt", i. e. low, stony ridges or protruding masses of rock in the low land. The vegetation upon these "Holts" is generally xerophilous in character and is, as a rule, not so rich in species as is the vegetation mentioned above. The ridges are usually more or less covered with soil which bears heath-vegetation, or are occupied by gravelly flats, therefore the Bryophyte vegetation consists chiefly of species belonging to heathland or grassland (*Hylacomium* spp., *Polytrichum alpinum*, *P. juniperinum*, *P. pilosum*, *Hypnum uncinatum*, *Frullania Tamarisci*, *Racomitrium* spp., etc.), while directly upon the rocks there grow species such as *Hypnum cupressiforme*, *H. hamulosum*, *H. revolutum*, *Orthotrichum* and *Grimmia* spp., and in the crevices *Bartramia*, *Pohlia cruda*, *Amphidium lapponicum*, *Mnium orthorrhynchum*, *Myurella*, *Distichium montanum* and other of the species found in rock-clefts in greater or smaller quantities.

The Bryophyte Vegetation of the Tuff Rocks.

The reason why the Bryophyte vegetation of the tuff rocks is here treated in a separate section is that the life-conditions of the plants are essentially different on a basalt and on a tuff substratum. Tuff consists of consolidated fine-grained material (volcanic ash and dust) through which are scattered larger and smaller blocks of rock. While the basalt has a smooth surface, with fissures and depressions only here and there, the surface of the tuff is uneven and

rough, and therefore offers more favourable conditions to the mosses for attaching themselves to it. When a basalt and a tuff surface occur side by side, as is often the case, the difference is very obvious. Mosses grow more scantily on basalt, since it is distinctly seen that the majority of the tufts are situated in, or proceed from,



Fig. 31. Tuff cleft (Bleikságil) near Barkarstadr.

a fissure, while tuff surfaces are often covered with a continuous moss-carpet, composed of many different species. It is also a fact of great importance that the water which flows down from above, and atmospheric humidity, are available to the mosses of basalt surfaces only as long as the water is flowing or is deposited, while the tuff is able to absorb water through its porose surface, and thus has a constant supply of necessary moisture for the vegetation. Owing to the slight power of resistance of the tuff against the ero-



Fig. 32. Side of tuff-cleft near Barkarstadr. At the foot of the cleft, among others *Mnium undulatum* grew abundantly. On the sides there grew *Hypnum filicinum* (at the top, to the right), *Fegatella conica* (in the middle and to the left), *Philonotis fontana*, *Mniobryum albicans* and many other mosses.

sive action of water, many more clefts and caves with damp surfaces are met with here than on the basalt, and these provide ideal habitats for a great number of mosses.

Tuff deposits of volcanic origin are found in many places in

Iceland, but the reason why in the following only the Bryophyte vegetation of South Iceland is mentioned, is because it is only this part of Iceland that has been somewhat thoroughly investigated.

Fljótshlíð. North of the great river Markarfljót, the country rises to a height of 200—600 metres. The slope stretching downwards to the Markarfljót is trenched by a great number of smaller streams, many of which flow at the bottom of deep, narrow clefts in the tuff-layers.

One of the longest and deepest clefts is Bleikságil near Barðarstadr (Fig. 31). This cleft has almost everywhere vertical or overhanging sides, 100 or more metres in height, and is so narrow at the top that in some places goats can jump across it. It is therefore quite inaccessible for the greater part of its length, hence only its lower part has been investigated. The sides were there usually covered with enormous mats of mosses of which the principal species were *Hypnum falcatum*, *H. filicinum*, *H. molluscum*, *Brachythecium rivulare* and *Philonotis fontana*, all of which were developed to an unusually luxuriant degree. *H. falcatum* and *H. filicinum* were in many places thickly covered with ripe capsules.

In this moss carpet a great number of other Bryophyta were found, partly intermixed with each other, partly in larger or smaller tufts or growths. The following species were observed: *Philonotis tomentella*, *Bryum æneum*, *B. pallens*, *B. ventricosum*, *B. inclinatum*, *Mniobryum albicans*, *Mnium serratum*, *M. punctatum*, *Anomobryum filiforme*, *Encalypta ciliata*, *Didymodon rubellus*, *Barbula cylindrica*, *Distichium montanum*, *Hymenostylium curvirostre*, *Anæctangium compactum*, *Amphidium Mougeottii*, *A. lapponicum*, *Haplozia riparia*, *H. cordifolia*, *Lophozia quinquedentata*, *L. Mülleri*, *Scapania irrigua*, *Blepharostoma trichophyllum*, *Madotheca Cordæana*, *Radula complanata*, *Metzgeria furcata* and *Marchantia polymorpha*. At the base of the rock-side grew, among others, *Mnium undulatum* and *Thuidium tamariscinum*. At the extreme end of the cleft, where the sun could shine on the rock faces, fruiting specimens of *Preissia commutata* often grew in abundance. The walls in the numerous caves were often covered with *Eurhynchium Swartzii* and *Fegatella conica*, in company with many, or a few, of the species found on the sides of the cleft, which, however, on the whole, did not thrive well in the scanty light. In many places *Fegatella* formed also a belt along the basal part of the rock-sides, especially where they projected. On the roof of the caves *Blepharostoma trichophyllum* and *Ambly-*

stegium Sprucei formed thin, dark-green coverings, and where the water flowed down the roof and walls *Thamnium alopecurum* occurred as pure growths.

A similar vegetation was found everywhere in clefts and caves, and where the conditions pertaining to light and moisture were more varying, the number of the species was still greater than in the vegetation described above. This was for instance the case in the deep and broad Flokastadagil near Breidabolstadr. There, on the damp walls, almost the same species were growing as in

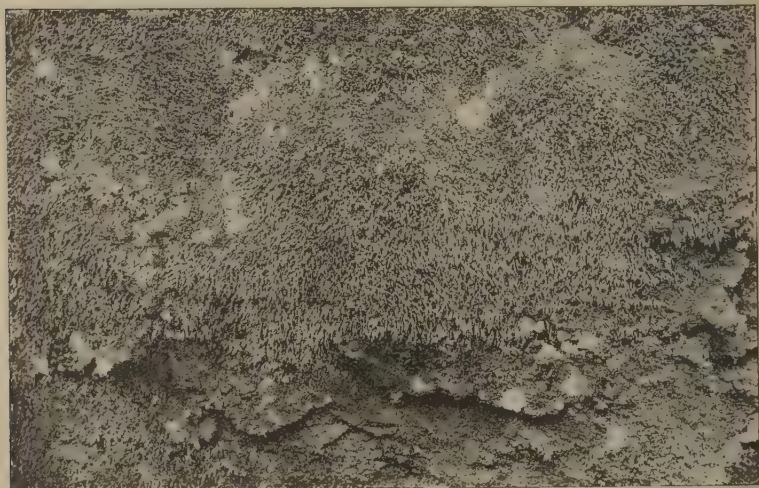


Fig. 33. *Bryoxiphium norvegicum* on one of the sides of Flokastadagil.

Bleikságil. A high, dry, perpendicular rock-face was for a considerable distance entirely covered with a shining, dark-green mat of *Bryoxiphium norvegicum* (Fig. 33), which has hardly been found elsewhere in such enormous quantities. In other places *Grimmia torquata* covered the rock-sides and blocks with its irregularly-rounded cushions, and *Hypnum palustre* was very common everywhere at the water's edge. *Neckera complanata* was common in dry ditches.

At the side of a small waterfall, Klitnafoss, there was a rather large cave, down one side of which some of the water from the waterfall was running. There *Thamnium alopecurum* grew abundantly, while the drier walls of the cave were covered with *Eurhynchium Swartzii* and *Mnium orthorrhynchum*. On the ground at the

bottom of the cave there grew *Timmia austriaca*, *Bryum ventricosum*, *Brachythecium rivulare*, *Thuidium delicatulum* and *Marchantia polymorpha*, and at the entrance to the cave where the water was dripping down, *Mnium undulatum* occurred. The upper part of the walls and the roof were covered with *Blepharostoma trichophyllum*, *Amblystegium Sprucei*, *Metzgeria furcata* and *Radula complanata*, and in the better-lighted part around the entrance, the cave was covered with *Homalothecium sericeum* and *Orthothecium intricatum*.

The Southern Slope of Eyjafjall consists partly of basalt and partly of tuff-layers. The numerous rivers which issue from the Jökull usually flow at the bottom of deep, narrow clefts in the tuff-layers.

Holtsá, which is a glacier-river of rather considerable size, flows for almost its entire course, from the Jökull down to the low land, at the bottom of deep clefts which are accessible only in a few places, the water usually rising from the bottom up to the perpendicular rock-wall. The sides are, as a rule, rather damp, and the water from the slopes above often flows down the rock-faces. The Bryophyte vegetation is extremely luxuriant, and the sides of the clefts are, for considerable distances, covered with enormous carpets of mosses and liverworts. The following species covered the fallen blocks and débris at the base of the cleft-sides: *Hylocomium* spp. (especially *H. squarrosus* and *H. proliferum*), *Hypnum stellatum*, *Acrocladium cuspidatum*, *Climacium dendroides*, *Eurhynchium Stokesii*, *Thuidium tamariscinum*, *Mnium undulatum*, *M. punctatum*, *Timmia austriaca*, *Marchantia polymorpha*, etc. In the numerous open caves and under overhanging rocks, a characteristic vegetation of *Marchantiaceæ* was found. *Preissia commutata* (fr.) and *Fegatella conica* covered the sides with metre-broad mats, and *Reboulia hemisphærica* occurred abundantly in several places, and was also fruiting. Here *Eurhynchium Swartzii* also was at home, especially on the less damp rock-faces, while *Thamnium alopecurum* preferred spots where the water was flowing down. Where streamlets were running from above down the rock-sides, there grew *Rhynchostegium rusciforme*, *Brachythecium rivulare*, *Haplozia cordifolia* and, lowermost, *Thamnium*, while the more or less damp rock-faces were covered with a variegated carpet of mosses and liverworts, unusually rich in species and composed of *Hypnum filicinum* (in masses), *H. falcatum* (in masses), *H. molluscum* (in masses), *Philonotis tomentella*, *P. fontana* (in abundance), *Mnium serratum*, *M. stel-*

lare, *M. orthorrhynchum*, *Bryum æneum*, *B. inclinatum*, *B. pallescens*, *B. ventricosum*, *Mniobryum albicans* (common), *Pohlia cruda*, *Plagiobryum Zierii*, *Anomobryum filiforme* (in one place in fr.), *Amphidium Mougeottii*, *A. lapponicum*, *Anœtangium compactum*, *Hymenostylium curvirostre*, *Blindia acuta*, *Ditrichum flexicaule*, *Distichium montanum*, *Barbula cylindrica*, *Didymodon rubellus*, *Tortella tortuosa*, *T. fragilis*, *Grimmia apocarpa*, *Myurella julacea*, *Haplozia riparia*, *H. atrovireus*, *Madotheca Cordæana*, *Lejeunea serpyllifolia*, *Radula complanata*, *Metzgeria furcata*, *Chiloscyphus polyanthus*, *Lophocolea cuspidata* (scanty), *Scapania irrigua*, *Lophozia quinquedentata*, *L. Mülleri* and *Aneura pinguis*. The moss-carpet covering dry rock-faces and large blocks was chiefly composed of *Hylocomium loreum* (also in fr.), *H. proliferum*, *Hypnum uncinatum*, *H. hamulosum* and *H. callichroum*. In a dry cave above the cleft there grew *Neckera complanata*, *Brachythecium populeum*, *B. velutinum*, *Plagiothecium denticulatum*, *P. depressum*, *Isothecium tenuinerve*, *Mnium cuspidatum*, and on the roof of the cave there grew *Amblystegium Sprucei* and *Blepharostoma*.

The southern side of Drángshlidarfjall and the small neighbouring group of mountains, Hrútafjall (Fig. 34), consist, in a great measure, of dry, lofty faces of tuff-rock, as much as 200 metres high, the base of which is moss-grown. One of the commonest species here is *Leucodon sciuroides* var. *morensis* which covered the rock-face for a considerable distance upwards with its extensive and often richly-fruiling mats. The following species were also common: *Homalothecium sericeum*, *Pterigynandrum filiforme*, *Hypnum revolutum* and *Grimmia torquata*. At the foot of the rock-faces there grew *Isothecium myurum* (in abundance), *Orthotrichum rupestre*, *Didymodon rubellus*, *Barbula cylindrica*, *Bryum capillare*, *Tortella tortuosa*, *Encalypta ciliata*, *Neckera complanata*, *Myurella julacea* and *Metzgeria furcata*, and where the water was oozing through cracks and crevices the rock-face was covered with *Blindia acuta* intermixed with *Hypnum molluscum*, *H. palustre* and the rare *Anomobryum concinnum*.

Among the large blocks of tuff on a small Urd there grew, among others, *Mnium undulatum*, *Eurhynchium piliferum*, *Rhynchostegium murale* (abundantly), *Amblystegium Juratzkanum*, *Leskea nervosa* and *Lejeunea cavifolia*.

The walls in the interior of a rather dry, open cave, were covered with *Preissia commutata*, *Fegatella conica*, *Marchantia polymorpha*, *Distichium montanum*, *Bryoxiphium norvegicum*, *Anœtangium*

compactum (all in abundance), *Reboulia hemisphaerica*, *Mnium orthorrhynchum*, *Funaria hygrometrica*, *Bryum cœneum*, *B. inclinatum*, *Orthothecium intricatum*, *Blepharostoma trichophyllum* and, where it was somewhat damper, with *Eurhynchium Swartzii*.



Fig. 34. Hrótafell south of Eyjafjallajökull. The perpendicular face of tuff-rock in the centre, is about 200 metres high, and, at the foot is covered with extensive moss carpets, whilst caves occur in many places.

A very interesting kind of vegetation was found on the dry faces of a small isolated rock, Drángshellir. There grew *Leucodon sciuroides* var. *morensis*, *Homalothecium sericeum*, *Leskea nervosa*, *Grimmia Doniana*, *Barbula muralis*, *B. obtusifolia*, *Orthotrichum anomalum* and *O. rupestre*. Half of these species consist of xerophilous southern forms, which have their northern limit in South Iceland, and are there met with only in specially protected localities. Drángshlid, which has a height of 478 metres, protects this locality

from the cold, north winds, without, however, preventing the sun from warming the tuff-faces.

The Bryophyte Vegetation of the Lava-fields.

A very great part of Iceland is covered with lava. According to Thoroddsen (1914, p. 219) the post-glacial lava-fields of Iceland cover an area of about 11,200 square km. or almost $\frac{1}{9}$ of the entire area of the island. It is, however, only a very small part of this vast area which has been an object of bryological investigation. Grönlund (1874, p. 136 and 1890) was the first to mention the vegetation of the lava-fields, in his description of the *Racomitrium* heath as important for the further development of the plant covering. Ostenfeld (1898, p. 246) has given a description of the lava-fields of the peninsula of Reykjanes without, however, entering more closely into the subject of the Bryophyte vegetation. Helgi Jónsson (1900, p. 89) has given a very detailed account of the vegetation of Búdahraun and Eldhraun in West Iceland, also with regard to the Bryophyta, and the same author, in his description of the vegetation of South Iceland, mentions the Bryophyte vegetation of several lava-fields, especially modern ones. Lastly, A. Wegener in 1912 made a few collections on the high-lying Odáðahraun (600—1200 metres above sea-level).

Besides a small part of Mývatnshraun, around the farm Reykjahlid, which was very superficially investigated owing to the inclemency of the weather, my own investigations include only the lava-fields of SW. Iceland, especially Hafnarfjardarrhraun, Thingvallahraun and Svinahraun around Kolvidarhol.

The lava-field is no single formation, but, on the contrary, includes a great number of different formations, ranging from the dry rock-flats and the *Racomitrium* heath, through the heather moor and grassland to the bog formations in the deepest hollows, and the associations of damp rocks in clefts. When it is nevertheless described here in a separate section, as by Helgi Jónsson, the reason is that the vegetation of the lava-fields of the lowlands everywhere presents so many common features and peculiarities that we may be justified in describing the Bryophyte vegetation occurring there.

According to the nature of the surface, the lava-fields may be classified into two groups, viz. block-lava (Icelandic *Apalhraun*) and sheet-lava (Icelandic *Helluhraun*). The former consists of blocks of

lava thrown together into irregular heaps, while sheet-lava consists of large, irregularly broken surfaces, which are formed by a process of slow solidification, and are furrowed by innumerable clefts and fissures, both narrow and broad. Here vesicular hollows are also found, produced by the moisture of the substratum which has formed large steam-vesicles in the molten lava, and after solidification the

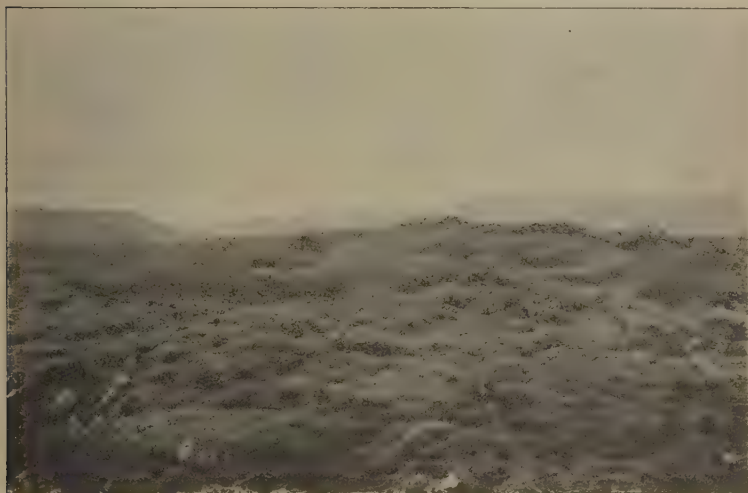


Fig. 35. Lava-field in the district of Borgarfjörður. The lava is covered to a depth of one foot with a layer of *Racomitrium hypnoides*. Projecting parts of the lava are covered with crustaceous lichens. Here and there a tuft of *Festuca ovina*. Birch coppice in the background.

roof of the vesicle has collapsed, and has formed a platform on the floor of the cavity. Such vesicles in the lava — which are characterized by very luxuriant vegetation, since they afford excellent shelter for the plants, and are inaccessible to sheep — may differ rather greatly in depth, according to the thickness of the lava-sheet. In Budahraun, according to Jónsson, their depth averages from 2—6 metres, but is usually somewhat above 2 metres, and in Hafnarfjardarrhraun the depth was also usually some 2 metres. The lava-fields are often furrowed by deep clefts or cracks, frequently of considerable length and with perpendicular sides. This is, for instance, the case in Thingvallahraun where the best-known cleft, Almannagjá, has a length of almost 15 kilometres.

The surface of the lava-field is very dry, because the water can easily drain away through the cracks, therefore, the vegetation there is decidedly xerophilous. As a rule, the *Rhacomitrium* heath (*R. hypnoides*) — in which other Bryophyta, such as *Dicranum scoparium*, *Hylocomium proliferum* and *Plitidium ciliare*, occur only extremely scantily — covers the greater part of the lava-fields, and there arrives at its fullest development, so that extensive areas may be found covered with foot-deep, soft, greyish carpets which hide all irregularities of the surface. The importance of the moss-covering for the further development of the plant-covering, partly by binding the drifting sand, partly by forming soil, has been demonstrated by Grönlund and Helgi Jónsson.

The chief reason for the extensive distribution of the moss-heath must undoubtedly be sought in the nature of the surface. This is, as a rule, highly vesicular, and contains numerous small holes and cavities, in which the plants find good conditions for taking root. Therefore, many of these cavities are filled up with small moss-cushions (Fig. 36), which, from thence, extend over the rock-surfaces and gradually merge into one another (Helgi Jónsson, 1900, p. 83).

The tops of the lava-cones and the protruding blocks are not covered with a continuous moss-carpet, but usually with scattered cushions of mosses, liverworts and lichens. The most frequent species there are *Rhacomitrium heterostichum*, *R. fasciculare*, *Grimmia apocarpa*, *G. funalis*, *Andreæa petrophila*, *Hypnum revolutum*, *Homalothecium sericeum*, *Pterigynandrum filiforme*, *Dicranoweisia crispula*, and occasionally *Gymnomitrium coralloides*, *G. concinnum*, *Dicranum fulvellum*, *Rhacomitrium sudeticum*, *Polytrichum pilosum*, besides which there are several other species. Thus, near Hafnarfjörður (and partly also in Búdahraun), in addition to the majority of the species mentioned above, there occurred *Orthotrichum rupestre*, *O. Sturmii*, *Grimmia patens*, *Leucodon sciuroides* var. *morensis*, *Isothe-cium tenuinerve* and *Frullania Tamarisci*. Near Thingvellir, where the surface of the lava is very dry, there grew upon the lava-cones many crustaceous lichens, *Rhacomitrium fasciculare* (in abundance), *Grimmia apocarpa*, *Andreæa petrophila*, *Polytrichum pilosum* and, here and there, some *Gymnomitrium coralloides* and *Dicranum fulvellum*: and, where some soil had accumulated, *Ceratodon purpureus* and *Pohlia nutans* grew scantily. In the depressions *Rhacomitrium hypnoides* was gradually replaced by *R. canescens*, heather moor and grassland, and in the deepest depressions small patches of bog and

swamp vegetation may occur. The *Rhacomitrium* heaths are gradually transformed into heather moors and birch coppices through the decaying of the mosses and their forming humus. But all these

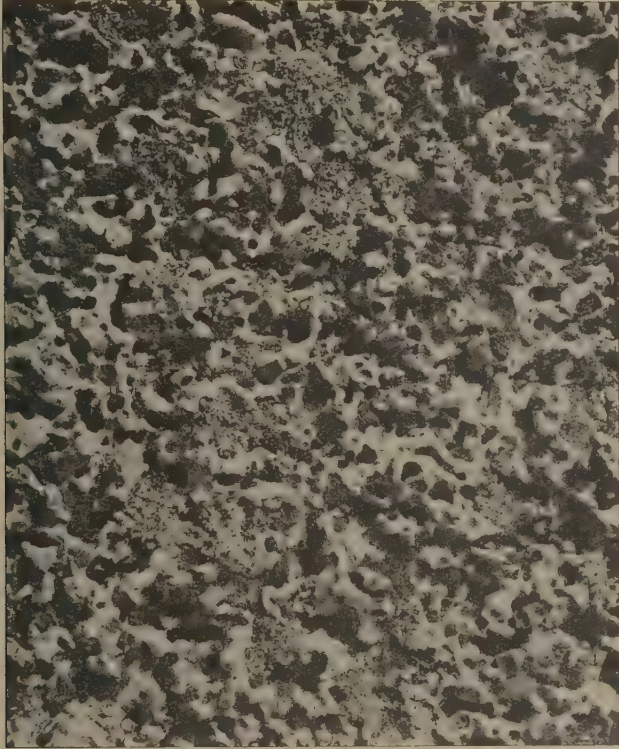


Fig. 36. The surface of a lava block with small moss-cushions (*Andreaea*, *Grimmia* spp. and *Gymnomitrium coralloides*).

formations will not be treated of more fully here as the mosses occurring in them have been mentioned in previous sections. Very extensively distributed and very characteristic is the *Rhacomitrium-canescens* formation which often replaces *R. hypnoides* in flat depressions where the ground is somewhat damp, and where some sand has accumulated. It is often abundantly mixed with other Bryophyta such as *Hylocomium* spp., *Hypnum uncinatum*, *Dicranum scoparium*, *Polytrichum alpinum* and species of *Lophozia*.

Lava-clefts. The caves, clefts and cavities which occur everywhere in the lava-fields contain a Bryophyte vegetation very rich in species. In the broader clefts and in the lava-vesicles (Helgi Jónsson's "Herb-cavities", 1900, p. 90) the bottom is often covered



Fig. 37. Lava-cleft near Thingvellir (Almannagjá). The lava-blocks are quite covered with *Rhacomitrium hypnoides*.

with ferns and flowering plants, and especially in deeper clefts, or where the bottom is covered with loose blocks, there is also found a continuous carpet of mosses and liverworts in which *Hylocomium* spp. (*H. proliferum*, *H. parietinum*, *H. loreum*, *H. squarrosum* and *H. triquetrum*) together with species of *Rhacomitrium*, *Hypnum* and *Dicranum* play a prominent part, and are usually much interwoven with liverworts such as *Lophozia lycopodioides*, *L. quinquedentata*, *L. Kunzeana*, *Cephalozia* spp., *Alicularia scalaris*, *Ptilidium ciliare*, etc.

Very frequently a large form of *Hypnum callichroum*, with regularly two-rowed ramification, is the most abundant constituent of the vegetation, especially in somewhat damp and shady clefts. *Eurhynchium piliferum* is often met with very abundantly, especially where



Fig. 38. Lava-cleft near Thingvellir. At the bottom there is a very luxuriant vegetation of ferns, *Geranium silvaticum*, etc., and in the crevices large moss-cushions occur everywhere.

the bottom is grass-covered, and several other southern forms, for instance *Eurhynchium Stokesii* and *Isohecia myurum*, likewise have a preference for the sheltered lava-clefts.

In the very deep lava-clefts the conditions are somewhat different from the aforesaid. Where the cleft is broad enough to allow the sun to shine on the bottom during a part of the day, a luxuriant covering of ferns, flowering plants or mosses is found (Fig. 38); but where the cleft is so narrow that the light is strongly subdued, the

higher plants and the *Hylocomium* mats do not thrive. The snow lies here till far into the summer, and in many cases the temperature hardly ever rises above freezing point. The bottom of these clefts is therefore either quite bare of vegetation, or covered only with mosses. At the bottom of narrow clefts (15—20 metres or more in depth) near Thingvellir, where snow and ice were still to be found even at the end of July, *Anthelieta* occurred on a damp substratum as they do on flats irrigated by melting snow on mountain heights. *Polytrichum sexangulare* and *Pohlia commutata* grew abundantly here as on rocky flats. The plants were considerably higher and more slender than on the rocky flats, and only slightly tomentose. The same was the case with *Conostomum boreale* and *Mniobryum albicans*, which likewise occurred in several clefts. The Bryophyte vegetation occurring there is affected both by the low temperature and also the deficient light and total absence of wind, which all combined contribute to produce a stronger longitudinal growth and a slighter development of rhizoids. Several other species, which have their main distribution on mountain heights, and are rare in or quite absent from the lowlands, are widely distributed about the lava-fields. In almost all the lava-fields of South-west Iceland, *Pleuroclada albescens* var. *islandica*, *Dicranum molle*, *D. Blyttii* and *D. Starckeii* are commonly found in clefts, not only in those that are narrow, but especially in the broad moss-grown clefts, where *Dicranum* spp. form large tufts on the blocks of lava.

On the sides of the clefts and of the fallen blocks, a great many mosses grow. *Diplophyllum albicans* is a character-plant of the lava-fields of SW. and W. Iceland; it is extremely common there, but is very rare and scanty in other localities. On the vertical, dry sides of clefts the mosses usually grow in large rounded cushions. The commonest species are *Tortella tortuosa*, *Anœtangium compactum*, *Amphidium Mougeottii*, *Grimmia torquata* and *G. funalis*, but many other of the species occurring on rocks and on the ground are always found both on the walls and also on, and among, the blocks. The Bryophyte vegetation of lava-clefts has the greatest resemblance to that found on the Urd, but some of the most light-loving species are absent, for instance *Orthotrichum*, several *Grimmia* and *Rhacomitrium* spp. and *Dicranoweisia crispula*, while, on the other hand, others are found which belong to damp clefts or which need more shelter. Mesophilous forms are in the majority, whilst hygrophilous forms are, as a rule, entirely absent.

In the following pages some examples of the Bryophyte vegetation of lava-clefts will be described.

Thingvallahraun. The lava-clefts (Icelandic Gjá) there, are peculiar on account of their unusual depth (as much as 20—30 metres). Several of those situated nearest to the lake of Thingvellir have deep water at the bottom.

The Bryophyte carpet at the bottom of the clefts is composed of *Hylocomium loreum*, *H. proliferum*, *H. parietinum*, *H. squarrosum*, *Hypnum uncinatum*, *H. callichroum*, *H. stramineum*, *H. molluscum*, *Eurhynchium piliferum*, *Antitrichia curtipendula*, *Polytrichum alpinum*, *Racomitrium hypnoides*, *R. canescens*, *Dicranum Blyttii*, *D. Starckeii*, *D. molle*, *Sphagnum teres*, *S. Girgensohnii*, *Lophozia ventricosa*, *L. quinquedentata*, *L. Kunzeana*, *L. alpestris*, *Plilidium ciliare* and *Scapania irrigua*. On the sides of the clefts there grew especially *Anæclangium compactum*, *Grimmia torquata*, *G. funalis*, *Gymnostomum rupestre*, *Amphidium Mougeottii* and *A. lapponicum*. Intermixed with these, and in cushions on the ledges, in the crevices and among the blocks there grew: *Hypnum cupressiforme*, *Isoetecium tenuinerve*, *Plagiothecium pulchellum*, *P. denticulatum*, *P. silvaticum*, *Amblystegium Sprucei*, *Neckera complanata*, *Schistidium gracile*, *Racomitrium sudeticum*, *Sælania cæsia*, *Ditrichum flexicaule*, *Tortella tortuosa*, *Fissidens osmundoides*, *F. bryoides* (rare), *Pohlia cruda*, *P. commutata*, *Bartramia ityphylla*, *Conostomum boreale*, *Philonotis tomentella*, *Mnium orthorhynchum*, *Bryum pallens*, *Plagiobryum Zierii*, *Distichium montanum*, *Diplophyllum albicans* (in abundance), *Lophozia heterocolpos*, *Lejeunea cavifolia*, *Blepharostoma trichophyllum*, *Alicularia scalaris*, *A. geoscypha*, *Anthelia Juratzkana*, *Scapania subalpina*, *Pleurociada albescens* var. *islandica*, *Cephalozia bicuspidata*, *Eucalyx subellipticus*, *Gymnomitrium concinnum*, *Metzgeria furcata*, *Radula complanata*, *Aneura pinguis* and *Preissia commutata*.

The above list is very long, but is nevertheless hardly complete, since some of the common chomophytes are not enumerated in it, and, at any rate, several of them were undoubtedly forgotten, while the list was being made on the spot, but it gives a good idea of the exceedingly great number of species which are found in these localities.

Hafnarfjardarhraun. Almost the same species are found there as in Thingvallahraun, but the situation close to the sea-side makes its influence felt. *Racomitrium heterostichum* and *R. fasciculare* are exceedingly common, and in several places *Ulotia maritima*

occurs on lava-blocks and *Trichostomum littorale* on the sides of the clefts. *Scapania dentata* was frequent on the ground at the bottom of shady, damp clefts. *Reboulia hemisphaerica* and *Frullania fragilifolia* were found in a single spot on the walls of caves.

On the ground at the bottom of deep, dark caves, shade-forms are often found, especially of *Hepaticæ*, with greatly elongated shoots and expanded, widely scattered leaves. Here, it was especially the following species which were common: *Cephalozia bicuspidata*, *Pleuroclada albescens* var. *islandica*, *Alicularia scalaris* and *Blepharostoma trichophyllum*, occasionally also *Preissia commutata* and in a single spot *Ditrichum homomallum* and *Oligotrichum hercynicum*.

Svinahraun is situated about 30 km. south-east of Reykjavik, and about 250—300 metres above sea-level. The part which has been investigated is situated in the neighbourhood of the farm Kolvidarhol, and is of block-lava consisting of blocks and flags piled up into wild-looking heaps, some 10 metres high, with numerous clefts and caves. The top part is covered with an unusually thick and luxuriant mat of *Rhacomitrium hypnoides* from which other mosses and flowering plants are almost absent. On the walls there grew *Amphidium Mougeottii*, *Tortella tortuosa* and *Anæctangium compactum*. In caves and clefts there was a Bryophyte carpet consisting of *Hypnum uncinatum*, *H. callichroum*, *Hylocomium loreum*, *H. proliferum*, *H. parietinum*, *Lophozia quinquedentata*, *L. lycopodioides*, *L. Flörckei*, *Plagiochila asplenioides* and *Ptilidium ciliare*. *Diplophyllum albicans* was extremely common everywhere. In addition to the above the following were found more or less abundantly: *Polytrichum alpinum*, *Diphyscium sessile*, *Bartramia ityphylla*, *Conostomum boreale*, *Mnium orthorrhynchum*, *Pohlia cruda*, *P. commutata*, *Mniobryum albicans*, *Bryum elegans*, *Amphidium lapponicum*, *Rhacomitrium sudeticum*, *Schistidium gracile*, *Fissidens osmundoides*, *Dicranum scoparium*, *Distichium montanum*, *Sphagnum teres*, *Lophozia alpestris*, *L. quadriloba*, *Alicularia scalaris*, *Anthelia Juratzkana* and *Blepharostoma trichophyllum*.

It will be seen that the lava-fields here described greatly resemble each other, and that it is essentially the same species which constitute the bulk of the vegetation in all of them. Svinahraun is situated on the ridge of hills which extends along the whole length of the peninsula of Reykjanes, and the climate there is extremely cold and damp, which is proved by the fact that it is the *Rhacomitrium* heath which forms the last stage in the development

of the vegetation of the flats, and that many of the species of the low land are absent.

Unfortunately there was no opportunity of investigating the lava-fields of West Iceland more closely, since unfavourable atmospheric conditions with rain and fog, combined with a want of time, made a longer stay there impossible, but the conditions appear to be essentially the same as in South-west Iceland.

In his description of Búdahraun Helgi Jónsson has also mentioned some mosses, and, as far as is possible to judge from the lists which, however, are no doubt incomplete, the conditions there are exactly like those in Hafnarfjardarhraun. There also coastal species are found, for instance *Ulota maritima*, and southern species such as *Eurhynchium Stockesii* and *Lejeunea cavifolia*, and the dominant species are quite similar to those in the lava-fields of South-west Iceland.

In North Iceland the Bryophyte vegetation of the lava-fields has an essentially different composition from that in West and South-west Iceland. All the lava-fields there are situated at a distance from the coast, and at a higher level above the sea, the vegetation is therefore decidedly xerophilous both on exposed surfaces and in clefts and crevices. The immense lava-flats at a great height above sea-level, are deserts almost entirely void of vegetation; they have, however, been very little investigated. There are to hand only a few collections from Koch's tour across Odáðahraun in 1912, and these consist only of *Tortula ruralis*, *Ceratodon purpureus* and *Dicranoweisia crispula*, which grew here and there upon the lava.

The only lava-field which has been investigated is Mývatns-hraun, which is about 160 years old, and upon which the farm Reykjahlid stands. It was described by Grönlund in 1890 and does not appear to have undergone any great change since that time. The *Rhacomitrium* heath occurred only scantily in the depressions, while the lava-cones were bare of vegetation or covered with scattered moss-cushions and crustaceous lichens. In the intervening space between the farm and the lake the following species were observed: Upon the blocks and on the lava were found *Tortula ruralis*, *Ceratodon purpureus*, *Rhacomitrium hypnoides*, *Grimmia Doniana*, *Schistidium confertum*, *Dicranoweisia crispula*, *Polytrichum pilosum* and *Hypnum revolutum*, all of which were very common. In sandy soil, especially in depressions, there grew *Desmatodon latifolius* and *Rhacomitrium canescens*. In dark caves and clefts *Lophozia*

lycopodioides was usually the only species found and it formed there extensive mats. On the ground among the blocks and on the sides of these blocks as also on those of broad clefts there grew *Brachythecium reflexum*, *Lescuræa filamentosa*, *Eurhynchium diversifolium* (scantily), *Polytrichum alpinum*, *Timmia austriaca*, *Bartramia ityphylla*, *Encalypta rhabdocarpa*, *Bryum elegans*, *B. inclinatum*, *Schistidium apocarpum*, *Didymodon rubellus* and *Plagiochila asplenioides*.

The above is a decidedly xerophilous flora from which not only all the mesophilous and hygrophilous forms from SW. Iceland, but also the lowland or southern forms proper, are entirely absent.

In several places in this lava-field the heat of the substratum makes itself felt in deep caves and clefts. In a warm, damp cave where the temperature was about 25° (outside 4°-5°) there grew *Fissidens osmundoides*, *Plagiothecium denticulatum*, *Calypogeia Trichomanis*, *Plagiochila asplenioides* and *Sphagnum rubellum*.

The development of the Bryophyte vegetation of the lava-fields has been very little investigated. The Bryophyta together with the lichens are the first plants which appear. The surface of the lava is very rough, consisting of small round cavities (lava vesicles) in which the spores find favourable conditions for germination, and form small rounded cushions which adhere very closely to the substratum and, if conditions are favourable, extend over the entire surface of the lava as a continuous carpet. It is, however, only in the most exposed parts of the lava-field, that the mosses are confined to the vesicles; this is not the case in the clefts.

Jónsson (1905, pp. 55 and 56) has given a description of Krakatindshraun near Hekla, a lava-field about 23 years old. The mosses grew there only in tiny, scattered cushions upon the lava, without anywhere forming continuous carpets; down in the clefts they grew somewhat more abundantly. There the following species were found: *Bartramia ityphylla*, *Pohlia cruda*, *P. commutata*, *Bryum pallens*, *Bryum* spp., *Ceratodon purpureus*, *Dicranoweisia crispula* (the commonest species), *Racomitrium hypnoides*, *R. canescens*, *Scapania curta* and *Lophozia alpestris*. The further development is exceedingly slow. On the flats *Racomitrium hypnoides* will usually grow over all the species and suppress them, but the formation of a continuous *Racomitrium* heath appears to require a very long time, in many cases, centuries, and the further development of the moss-heath into heather moor, birch coppice or other formations, through the decay of the mosses and their forming soil, undoubtedly takes place even more slowly.

II. THE BRYOPHYTE VEGETATION OF MOUNTAIN HEIGHTS.

In "Vegetationen paa Snæfellsnes" (Helgi Jónsson, 1900) the plant formations of mountain heights are classified into three groups, viz., Rocky flat, *Grimmia* heath and Mountain bogs. Of these the *Grimmia* heath (*Racomitrium* heath) has already been described in a previous section.

Rocky Flat.

By Rocky Flat Jónsson understands that part of the country which is situated above the upper limit of the heather moor (and the birch), with the exception of the mountain bogs and the *Racomitrium* heath. Its surface varies greatly, and consists sometimes of gravelly or clayey flats, sometimes of horizontal or sloping stony tracts, bare rocks or talus of débris, all of which, however, have one characteristic in common, viz., that higher plants do not form any continuous carpet, but grow scattered singly or in small societies in the most sheltered localities. The lower limit of the rocky flat varies greatly according to the local conditions. It generally begins at an altitude of about 300—400 metres, but often typical rocky-flat formations are met with at far lower levels, in NW. Iceland, for instance, as far down as to the sea-level.

Bryophyta play a very prominent part in the vegetation of the rocky flat, and are often dominant there, or form special Bryophyte associations.

The dry, gravelly flats are poor in plants, and are often quite devoid of vegetation. Of mosses, as a rule, only *Racomitrium hypnoides* is met with in scattered cushions, especially around somewhat large stones, where it can hold fast, and find some shelter. In somewhat damper and less exposed localities *Racomitrium* heaths are developed as in the lava-fields of the low land, but whilst the mosses in the low land gradually make room for other plant associations by accumulating the blowing sand around them, and by forming humus, this is not the case on the rocky flat. Here flowering plants occur extremely scantily in the *Racomitrium* heath, which therefore forms the final stage in the development of the plant-covering, and is not replaced by other formations.

On large stones on the rocky flat there grew jet-black cushions of *Andreæa petrophila*, *Dicranoweisia crispula*, *Racomitrium fasciculare*, *R. sudeticum* and *Schistidium apocarpum*.

On somewhat damper gravelly ground, especially where large blocks lie scattered and afford shelter, the Bryophyte vegetation becomes richer, so that here we sometimes find a continuous carpet of mosses and liverworts, through which the tops of the stones protrude. This carpet of mosses and liverworts is usually composed of a larger or smaller number of the following species: *Hylocomium proliferum*, *Hypnum uncinatum*, *Brachythecium reflexum*, *Lescuræa Breidleri*, *Racomitrium hypnoides*, *R. fasciculare*, *R. sudeticum*, *R. canescens*, *Schistidium apocarpum*, *S. gracile*, *Bryum ventricosum*, *Pohlia commutata*, *P. cucullata*, *P. gracilis*, *Philonotis fontana*, *Conostomum boreale*, *Dicranum Blyttii*, *D. molle*, *D. Starckeii*, *D. congestum*, *Polytrichum sexangulare*, *Oligotrichum hercynicum*, *Lophozia alpestris*, *L. quinquedentata*, *L. ventricosa*, *L. lycopodioides*, *L. Flörckei*, *L. quadriloba*, *Alicularia scalaris*, *A. geoscypha*, *Pleuroclada albescens*, *Anthelia Juratzkana* and *Gymnomitrium concinnatum* besides some rare or more casual species, for instance *Eurhynchium diversifolium*, *Brachythecium glaciale*, *Aulacomnium turgidum*, *Bryum elegans*, *Bartramia ityphylla*, *Pohlia Ludwigii*, *Didymodon rubellus*, *D. rufus*, *Desmatodon latifolius*, *Distichium montanum*, etc. Usually several species grow intermixed, but the moss carpet may also be formed by a single species or a few. At elevations above 500—600 metres *Racomitrium sudeticum* often forms extensive growths on gravelly flats. Flowering plants are entirely absent, but lichens (*Cetraria islandica*, *Cladonia* spp. and *Stereocaulon condensatum*) may occur abundantly in this moss carpet. In the more low-lying parts of the rocky flat *Racomitrium sudeticum* rarely occurs abundantly, but is replaced by *Schistidium gracile* and *Schistidium apocarpum*, which form low, blackish-brown or reddish-brown mats. *Lescuræa Breidleri* is a common species, especially in NW. Iceland, where it is in many places the most abundant constituent of the vegetation on stony slopes. *Conostomum boreale* is also common, especially in NW. Iceland where, on the dry gravelly flats of the mountain heights, the intervening spaces between the stones are filled up with its compact tufts. *Brachythecium glaciale* in company with *Hypnum stramineum* covered the damp areas of the rocky flat near Isafjörður, at a height of 450—500 metres. In the channels, in which the water is drained away during the melting of the snow, the stones are often entirely covered with *Mniobryum albicans* var. *glacialis*, and in damp spots and near springs *Philonotis fontana* forms light-green cushions, as it does near the “Dý” in the more low-lying tracts. In the following

pages some examples of the rocky-flat vegetation will be given, it is, however, only in NW., SW. and in a few districts of N. and E. Iceland, that this vegetation has been somewhat closely investigated, whilst the whole of the interior high land is quite unknown as far as bryology is concerned.

1. South Iceland. Barkarstadr, dry stony flat at an altitude of 350 metres: Scattered cushions of *Schistidium apocarpum* v. *rufescens*, *Racomitrium hypnoides*, *R. fasciculare*, *Dicranoweisia crispula* and *Andreæa petrophila*.

2. Gravelly flat on Esja, at an altitude of about 550 metres: Moss carpet, partly torn up by the wind, composed of *Hypnum uncinatum* and *Schistidium apocarpum*, scattered in which occur rocky-flat plants such as *Silene acaulis* and *Saxifraga oppositifolia*.

3. Akureyri, rather dry gravelly flat, at an altitude of about 900 metres: Moss carpet composed of *Racomitrium hypnoides*, *Hypnum uncinatum*, *Hylocomium proliferum*, *Camptothecium nitens*, *Aulacomnium turgidum*, *Dicranum congestum*, *Didymodon rufus*, *Eurhynchium diversifolium*, *Lophozia quinquedentata* and *L. quadriloba*. Flowering plants entirely absent. On a dry slope at an elevation of about 770 metres there grew *Lescuræa Breidleri*, *Brachythecium glaciale*, *B. reflexum*, *Dicranum Starckeii*, *Lophozia lycopodioides* and *L. alpestris*, and on damp gravelly flats near the snow line there grew *Pohlia gracilis* (abundantly), *P. cucullata*, *P. comutata*, *Polytrichum sexangulare*, *Oncophorus virens*, *Dicranum Starckeii*, *Lophozia alpestris*, *L. ventricosa*, *L. quinquedentata*, *L. quadriloba*, *Pleuroclada albescens* and *Anthelia Juratzkana*.

Salix herbacea-*Sibbaldia* Vegetation (Helgi Jónsson, 1900, p. 33) occurs everywhere in damp depressions and on slopes where the subsoil consists of a layer of clay. This vegetation has its main distribution from 300—400 metres to about 700 metres, and here, close to the snow line, it is replaced by pure moss-communities, in which *Salix herbacea* occurs but scantily and at last disappears entirely. The moss community consists of a low, dense carpet of mosses and liverworts, interwoven with creeping stems of *Salix herbacea*, so that only the tips of the shoots protrude above the carpet. The most abundant constituent of this moss carpet is usually a low-growing form of *Hypnum uncinatum* or of *Dicranum Starckeii* in association with *Racomitrium canescens*, *Dicranum molle*, *Conostomum boreale*, *Polytrichum sexangulare*, *Anthelia Juratzkana*, *Pleuroclada albescens*, species of *Lophozia*, and sometimes other species.

Anthelia flats (Helgi Jónsson, 1900). In damp parts of the rocky flat, especially where the snow-water from the melting snow-flats spreads out over the ground, extensive flats of a greyish-black or bluish-black colour are very commonly met with, and these are principally formed of *Anthelia Juratzkana*. Interspersed in this *Anthelietum* occur several other Bryophyta of which the most frequent are *Alicularia scalaris*, *A. geoscypha* and *Lophozia alpestris*, while scattered plants of *Polytrichum sexangulare*, *Oligotrichum hercynicum* and *Pohlia gracilis* protrude here and there. *Pleuroclada albescens* is also occasionally met with.

Although the *Anthelia* vegetation also occurs in more low-lying tracts, yet it has its main distribution near the snow line, and must therefore be reckoned to the moss associations of the Snow region. There are only a few Bryophyta which occur in the Snow region. At the boundary between the *Anthelia*-flats and the drier gravelly flats *Dicranum falcatum* occurs in semiglobular cushions, densely matted with rhizoids, but it lies so loosely upon the gravel that one can lift up the whole cushion. Near Dýrafjörður *Gymnomitrium varians* grew in a similar manner to *Anthelia*, close to the melting snow-flats. *Dicranum Starckeii*, *D. Blyttii*, *Pohlia cucullata*, *P. commutata*, *Oligotrichum hercynicum* and *Polytrichum sexangulare* are also common near the snow line but, with the exception of a few species (*Dicranoweisia*, *Andreæa* and *Rhacomitrium* spp.) growing on rocks, the list is thereby exhausted.

Mountain Bogs

are extensively distributed in great parts of Iceland, but have not yet been more closely investigated. The vegetation in the boggy depressions often consists of a low, black mat of *Hypnaceæ*, mostly *Hypnum revolvens*, *H. exannulatum*, *H. sarmentosum* and *H. stramineum*; but the moss covering may also contain other species and, in composition, somewhat resemble the bog vegetation of the low land, although the species are fewer in number.

Near Akureyri boggy flats, situated 500—600 metres above sea-level, were partly covered with Hypneta and partly with *Cinclidium stygium* with scattered cushions of *Sphagnum* and species of *Lophozia*. On a wet flat, at an altitude of about 600 metres, there grew *Polytrichum commune* (in abundance), *Hypnum sarmentosum*, *H. stramineum*, *H. Lindbergii*, *H. uncinatum*, *Dicranum Starckeii*, *Sphagnum teres*, *S. Girgensohnii*, *Meesea trichoides*, *Bryum ventricosum*,

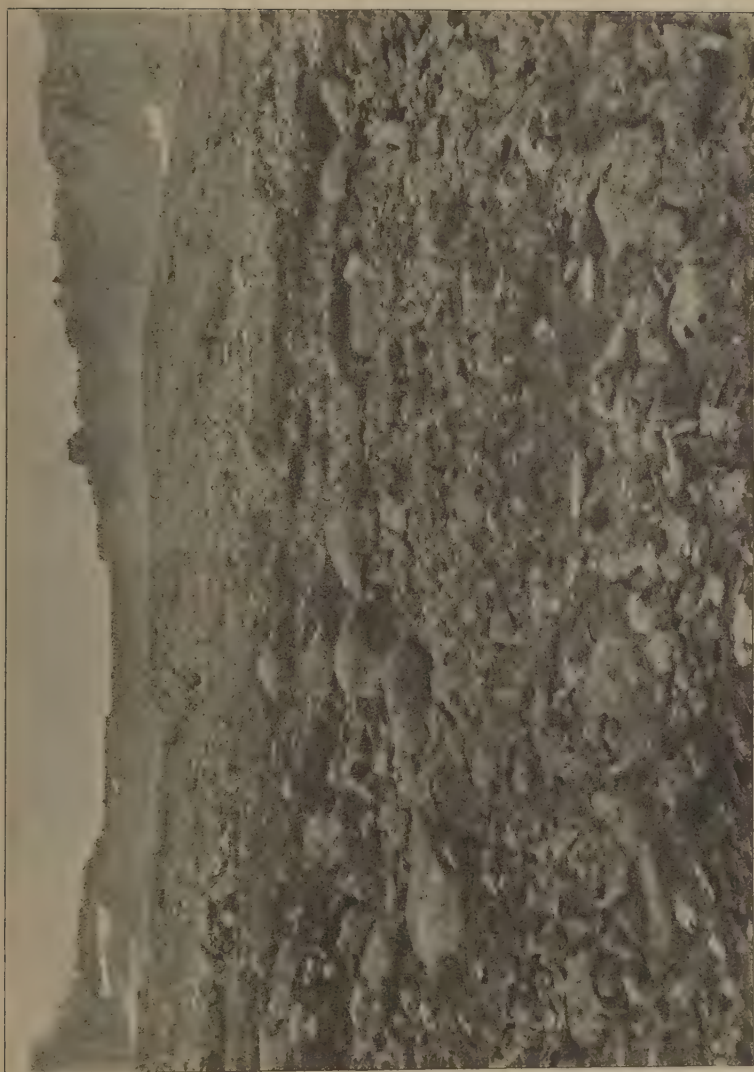


Fig. 39. Rocky flat near Isafjörður, about 500 metres above sea-level. On the larger stones *Rhacomitrium sudeticum* grows in extensive black cushions, and on the ground between the stones *Antheletia* and *Dieranum falcatum* occur. To the left in the middle-ground there is a flat with *Rhacomitrium sudeticum*.

Dissodon splachnoides, *Dichodontium pellucidum*, *Aongstræmia longipes* and *Lophozia Kunzeana*.

Barkarstadr (South Iceland). On a tract of knolly bog-land, 530 metres above sea-level, there grew *Hypnum turgescens*, *H.*

revolvens, *H. exannulatum*, *H. Richardsonii*, *H. sarmentosum*, *H. polygamum*, *Hylocomium squarrosum*, *Oncophorus Wahlenbergii*, *Dichodontium pellucidum*, *Aongstroemia longipes*, *Bryum ventricosum*, *Pohlia gracilis*, *Dissodon splachnoides*, *Dicranum congestum* (in the *Sphagnum*-tufts), *Sphagnum teres*, *Alicularia scalaris*, *Scapania irrigua* and *Anthelia Juratzkana*.

Judged from a botanical point of view, the interior high land has been very superficially investigated. As regards the mosses, only a few collections are to hand, which were made by A. Wegener during Koch's tour through the island in 1912. But as regards almost all these collections, conditions pertaining to soil and height above sea-level have not been more closely notified.

Hvannalindir (altitude 656 metres): *Hypnum stellatum*, *H. revolvens*, *Philonotis fontana*, *Pohlia commutata* (fr.), *Distichium montanum*, *Splachnum vasculosum* and *Aongstroemia longipes*.

Eyolfssjall (June 22nd): *Aulacomnium palustre*, *Philonotis tomentella*, *Bartramia ityphylla*, *Bryum ventricosum*, *Cinclidium stygium*, *Timmia norvegica*, *Mnium affine* var. *integrifolium*, *Pohlia cruda*, *Distichium montanum*, *Dichodontium pellucidum*, *Hypnum sarmentosum*, *Amblystegium Sprucei* and *Anthelia Juratzkana*.

Esjulfjall. *Racomitrium canescens*, *R. hypnoides*, *Distichium montanum*, *Philonotis tomentella*, *Mnium orthorrhynchum*, *Pohlia cruda*, *Bryum* spp., *Hypnum uncinatum*, *H. revolutum* and *Anthelia Juratzkana*.

Wet Bogs and River banks; June 22nd (without more particular specification of the locality). *Hypnum exannulatum*, *H. Kneiffii*, *Aulacomnium palustre*, *Philonotis fontana*, *P. tomentella*, *Mniobryum albicans* var. *glacialis*, *Pohlia commutata*, *Distichium montanum*, *Schistidium gracile* and *Aongstroemia longipes*.

These lists almost exclusively contain species which are of common occurrence everywhere.

III. THE COMPONENTS OF THE BRYOPHYTE FLORA.

IN consequence of the geographical situation and climate of the island, the vegetation of Iceland has a composition which corresponds most nearly to that of Scandinavia and South Greenland. With the exception of the species found only in Iceland, there is only one species (*Bryoxiphium norvegicum*) which has not been found in the other parts of Europe, but which has its home in North America, and one species (*Tortula obtusifolia*) which I do not think has been found in Scandinavia. The other species are all common to Iceland and Scandinavia. At present it is not possible to compare the Bryophyte flora of Iceland and Greenland, partly because there is no collective account of the distribution of the species found in Greenland, and partly because the older Greenland collections and lists of species greatly need revision.

The Bryophyta found in Iceland can be arranged in four geographical groups (Arnell and Jensen, 1910, p. 238): —

1. Ubiquitous species, which are almost equally distributed over the whole of North Europe as far as north of the Arctic Circle.
2. Meridional species, which are most frequent in Southern Scandinavia and far rarer in Northern Scandinavia.
3. Boreal species, which are more frequent in Northern than in Southern Scandinavia, and have their main distribution below the tree-limit.
4. Alpine species, which have their main distribution above the tree-limit.

In Table II and in the following Tables the plant-geographical character of the species is denoted by the initial letters u, m, b and a, which are prefixed to the name of the species. Icel. indicates that the plant is known only from Iceland. As already mentioned, the species found only on warm soil — almost all of which belong

to the meridional group — are not included in the present or following sections.

Table I. The Plant-geographical Groups.

	u	m	b	a	Icel.
Hepaticæ	28	18	19	22	
Sphagnales	11	2	4		
Musci veri	93	53	88	86	6
Total...	132	73	111	108	6

Of greatest interest in this connection is the comparatively large group of meridional species, which comprise about $\frac{1}{6}$ of all the species. According to their distribution in the different districts of Iceland they can be divided as follows: —

a. Found only in the Southern part of Iceland (South Iceland and most nearly adjacent parts of South-east and South-west Iceland).

Reboulia hemisphærica.	Hedwigia albicans.
Fegatella conica.	Orthotrichum anomalum.
Fossombronia Dumortieri.	— saxatile.
Aneura multifida.	— cupulatum.
Marsupella Funckii.	Mnium undulatum.
Jamesoniella autumnalis.	Leucodon sciurioides.
Lophozia excisa.	Anomodon viticulosus.
Lophocolea cuspidata.	Thuidium tamariscinum.
Lepidozia setacea.	— Philiberti.
Frullania fragilifolia.	Isothecium myurum.
Lejeunea cavifolia.	Scleropodium purum.
Sphagnum papillosum.	Eurhynchium piliferum.
Weisia crispata.	— Swartzii.
— viridula.	— Stockesii.
Trichostomum littorale.	Rhynchostegium murale.
Barbula unguiculata	Plagiothecium depressum.
var. cuspidata.	— elegans.
Tortula muralis.	Amblystegium fluviatile.
— mucronifolia.	Hypnum molluscum.

b. Most common in South Iceland, rarer in the other parts of the island.

Madotheca Cordæana.	Thuidium delicatulum.
Barbula cylindrica.	Thamnum alopecurum.
Mnium serratum.	Rhynchostegium rusciforme.
Catharinea undulata.	Camptothecium lutescens.
Neckera complanata.	Hypnum commutatum.

c. Found only in a single locality, or in a few localities, in the different parts of Iceland.

Haplozia crenulata.	Bryum bimum.
Lophozia barbata.	Mnium cuspidatum.
Lophocolea minor.	— stellare.
Diplophyllum obtusifolium.	Cylindrothecium concinnum.
Sphagnum angustifolium.	Eurhynchium strigosum.
Dicranum Bonjeani.	Amblystegium serpens.
Trematodon ambiguus.	— Juratzkanum.
Fissidens bryoides.	— trichopodium.
Leptodontium flexifolium.	Hypnum Sommerfeltii.
Barbula fallax.	— Sendtneri.

d. Frequent everywhere, or in large parts of Iceland.

Radula complanata. Common in South, East and West Iceland, absent from North Iceland.

Racomitrium aciculare. Very common all over Iceland.

Mnium hornum. Common, especially in South Iceland, rarer in North Iceland.

Pogonatum nanum. Common in several parts of West and South-west Iceland.

Metzgeria furcata. Common over the whole of Iceland.

The majority of the meridional species ($a = 37$ species and $b = 10$ species) have a decidedly southerly distribution. Of the species belonging to group c only *Lophozia barbata*, *Diplophyllum obtusifolium* and *Bryum bimum* have been found, each in a separate locality in East Iceland. The other habitats are equally distributed over South, West and North Iceland.

Table I shows that there is an almost equal number of Boreal and Alpine species and a somewhat larger number of Ubiquists, but in order to obtain a really comprehensive view of these groups, showing which has the greatest importance with regard to the composition of the vegetation, it is also necessary to investigate how many species with a somewhat high degree of frequency are contained in each group.

If all the species are included, the frequency of which — throughout a larger part of Iceland (besides South Iceland) — is expressed by the figure 3 (see p. 644) or upwards, the number of species contained in each group will be as follows: —

Table II. Species with the Frequency of 3 or upwards throughout a larger part of Iceland.

	u	m	b	a	
Hepaticæ	15	3	7	9	
Sphagnales	4				
Musci veri	55	4	49	24	
Total . . .	74	7	56	33	170

Group 1. Ubiquitous species.

* <i>Marchantia polymorpha</i> .	* <i>Cephalozia bicuspidata</i> .
* <i>Aneura pinguis</i> .	* — <i>Hampeana</i> .
* <i>Pellia Neesiana</i> .	* <i>Blepharostoma trichophyllum</i> .
* <i>Alicularia scalaris</i> .	* <i>Ptilidium ciliare</i>
* <i>Lophozia quinqueidentata</i> .	<i>Scapania dentata</i> .
— <i>ventricosa</i> .	* — <i>undulata</i> .
— <i>Mülleri</i> .	* <i>Frullania Tamarisci</i> .
* <i>Plagiochila asplenioides</i> .	
<i>Sphagnum Girgensohnii</i> .	<i>Funaria hygrometrica</i> .
* — <i>teres</i> .	* <i>Leptobryum pyriforme</i> .
— <i>Warnstorffii</i> .	* <i>Pohlia cruda</i> .
— <i>rubellum</i> .	* <i>Bryum inclinatum</i> .
	— <i>argenteum</i> .
<i>Gymnostomum rupestre</i> .	— <i>pallens</i> .
<i>Anectangium compactum</i> .	* — <i>ventricosum</i> .
* <i>Dicranum scoparium</i> .	* <i>Mnium affine</i> .
— <i>congestum</i> .	— <i>Seligeri</i> .
<i>Ceratodon purpureus</i> .	* — <i>punctatum</i> .
* <i>Ditrichum flexicaule</i> .	<i>Meesea triquetra</i> .
* <i>Didymodon rubellus</i> .	* <i>Aulacomnium palustre</i> .
* <i>Tortella tortuosa</i> .	* <i>Bartramia ityphylla</i> .
<i>Tortula subulata</i> .	* <i>Philonotis fontana</i> .
— <i>ruralis</i> .	<i>Pogonatum urnigerum</i> .
<i>Schistidium maritimum</i> .	<i>Polytrichum juniperinum</i> .
— <i>apocarpum</i> .	<i>Diphyscium sessile</i> .
* — <i>gracile</i> .	<i>Fontinalis antipyretica</i> .
<i>Racomitrium heterostichum</i> .	<i>Antitrichia curtipendula</i> .
* — <i>canescens</i> .	* <i>Pterigynandrum filiforme</i> .
* — <i>hypnoides</i> .	* <i>Climacium dendroides</i> .
<i>Amphidium Mougeottii</i> .	<i>Brachythecium albicans</i> .
<i>Ulotia maritima</i> .	<i>Plagiothecium Røseanum</i> .
<i>Orthotrichum rupestre</i> .	* <i>Hypnum stellatum</i> .
<i>Encalypta rhabdocarpa</i> .	* — <i>uncinatum</i> .

- *Hypnum exannulatum.
- * — filicinum.
- cupressiforme.
- * — Lindbergii.
- * — stramineum.

- *Acrocladium cuspidatum.
- *Scorpidium scorpioides.
- *Hylocomium proliferum.
- * — parietinum.
- * — squarrosum.

Group 2. Meridional species.

- Metzgeria furcata.
- Madotheca Cordæana.
- Radula complanata.
- *Rhacomitrium aciculare.
- Mnium hornum.
- Catharinea undulata.
- Camptothecium lutescens.

Group 3. Boreal species.

- *Alicularia geoscypha.
- *Lophozia lycopodioides.
- * — Kunzeana.
- *Chiloscyphus polyanthus.
- *Cephalozia pleniceps.
- *Scapania irrigua.
- * — curta.

- *Andreæa petrophila.
- *Dichodontium pellucidum.
- *Oncophorus Wahlenbergii.
- * — virens.
- Dicranella squarrosa.
- * — crispa.
- Dicranum Blyttii.
- Fissidens osmundoides.
- *Blindia acuta.
- *Distichium montanum.
- Tortella fragilis.
- Grimmia torquata.
- *Rhacomitrium sudeticum.
- * — fasciculare.
- *Amphidium lapponicum.
- Encalypta ciliata.
- Dissodon splachnoides.
- Splachnum sphaericum.
- * — vasculosum.
- *Pohlia gracilis.
- *Mniobryum albicans.
- Bryum purpurascens.
- lacustre.
- affine.
- cirratum.
- Bryum pallescens.
- * — Duvalii.
- *Mnium cinclidioides.
- *Paludella squarrosa.
- *Meesa trichoides.
- *Catoscopium nigrum.
- *Philonotis tomentella.
- *Timmia austriaca.
- Polytrichum strictum.
- gracile.
- *Myurella julacea.
- tenerrima.
- Lescuræa filamentosa.
- Thuidium lanatum.
- *Camptothecium nitens.
- Brachythecium reflexum.
- * — rivulare.
- Plagiothecium pulchellum.
- *Hypnum polygamum.
- * — revolvens.
- Kneiffii.
- decipiens.
- * — falcatum.
- * — giganteum.
- Hylocomium rugosum.

Group 4. Alpine species.

- *Gymnomitrium concinnum.
- *Haplozia cordifolia.
- atrovirens.
- Lophozia quadriloba.
- * — alpestris.
- Pleuroclada albescens.
- Anthelia julacea.
- * — Juratzkana.
- *Scapania subalpina.

* <i>Dicranoweisia crispula</i> .	* <i>Mnium orthorrhynchum</i> .
<i>Aongstroemia longipes</i> .	<i>Conostomum boreale</i> .
<i>Dicranum falcatum</i> .	<i>Philonotis seriata</i> .
* — <i>Starckeii</i> .	<i>Psilopilum lævigatum</i> .
— <i>molle</i> .	— <i>hercynicum</i> .
<i>Desmatodon latifolius</i> .	* <i>Polytrichum alpinum</i> .
* <i>Schistidium rivulare</i> .	— <i>sexangulare</i> .
<i>Grimmia Doniana</i> .	<i>Amblystegium Sprucei</i> .
* — <i>funalis</i> .	* <i>Hypnum revolutum</i> .
<i>Tetraplodon bryoides</i> .	— <i>alpestre</i> .
* <i>Pohlia commutata</i> .	* — <i>ochraceum</i> .
<i>Bryum arcticum</i> .	* — <i>sarmentosum</i> .

The species to which an asterisk has been prefixed have everywhere, or throughout the larger part of Iceland, the degree of frequency expressed by figure 4 (see p. 644), and consequently they constitute the bulk of the vegetation. Groups 1 and 3 include conjointly 75 (41 + 34) species, while group 4 has 15, and group 2 only one species which is very common everywhere.

IV. THE ALTITUDINAL DISTRIBUTION OF THE SPECIES.

THERE are only a few species which are equally common in the low land and on mountain heights. The majority of them are either Lowland forms, which rapidly decrease in frequency above a certain altitude and at last disappear completely, or Alpine forms which have their main distribution at greater heights above sea-level and decrease in frequency downwards. In countries with a continental climate it is, as a rule, not difficult to draw a somewhat sharp limit for the altitudinal distribution of plants, but the conditions for survey are far less favourable in a country like Iceland, where a cold and damp insular climate prevails in the coastal districts. On account of the low summer temperature, the majority of the Alpine species can thrive as far down as the low land, and conversely many of the lowland mosses will be able to establish colonies in favourable localities, which are situated essentially higher than their usual limit of growth. In South Iceland, for instance, I have seen a southern slope, at an altitude of above 500 metres, which was covered with species of *Hylocomium* together with other species belonging to the same formation.

As regards Iceland a fairly distinct boundary line may be drawn between the Lowland and Highland formations by taking the upper limit of the heather moor (and of the birch) as a basis for the classification (Helgi Jónsson, 1895—1899—1900); it is then seen that the upper limit of growth of a very great number of Bryophyta nearly coincides with the upper limit of the heather moor. The upper limit of the heather moor varies somewhat in the different parts of Iceland, and is also in a high degree dependent on local conditions such as shelter, direction of exposure, and conditions pertaining to moisture. In East Iceland the boundary line lies, as a rule, at about 300 metres, and the same is the case in the greater part of South-west, West and North Iceland. Around Mývatn, ac-

according to Thoroddsen's statement, the birch coppices ascend to 550 metres. In North-west Iceland the birch coppices in Dýrafjörður ascend to about 270 metres, and around Isafjardardjúp probably not very far above 200 metres. In South Iceland the upper limit of the heather moor generally lies at an altitude of 300—350 metres, but in sheltered valleys both birch coppices and heather moor may be met with at an altitude of above 500 metres. On the whole, the upper limit of the heather moor may, however, be reckoned to lie, on an average, at an altitude of about 300—350 metres.

All that is situated above this limit is in the following designated the Alpine region, since the willow region which occurs in the mountains of Scandinavia and Central Europe is not typically developed in Iceland; not, at any rate, in the coastal districts. The reason for this must in a great measure be sought in the geological structure of the country. The gradually-ascending or terrace-formed land near to the coast rises to a height of 200—300 metres, and from here the mountains almost everywhere shoot abruptly upwards to a height of 600—700 metres, right up to the plateau on the mountain summit, from which again a few peaks or rock-masses protrude. This leaves very little room for vegetation between 300 and 600 metres, with the exception of the valleys, which are, as a rule, very narrow. This is very decidedly noticeable in North-west and East Iceland, where almost everywhere along the coasts, from a quite narrow coast-land, the mountains rise abruptly to an almost constant height of 600 metres, so that only at the head of the valleys do terraces occur at various levels as far upwards as the mountain heights. In North Iceland, especially towards the east, the country rises more gradually up towards the interior high land, and there — at any rate somewhat inland — willow coppices and willow swamps occur also, but their Bryophyte vegetation has been very little investigated.

Taking the above as a basis the vegetation may be classified into zones, according to altitude.

- A. The Lowland region which reaches to the upper limit of the heather moor and the birch.
- B. The Mountain region which includes slopes and flats to a height of about 600 metres.
- C. Alpine Heights (the Snow region) to which is reckoned all that is situated higher than about 600—700 metres. The vegetation there is very poor in species, and is strongly affected

by the severe climate and the snow, which remains over extensive tracts till late in the summer, and saturates the soil with ice-cold snow-water.

In the following table the first column consists of the species which have been found in the Lowland region, the second column the species which have been found in the Mountain region, and the third the species which have been found in the Snow region. A cross (+) indicates that the species has its main distribution in the region in question; a dash (—) indicates that the species in question decreases in frequency and extends to a more or less high level (or low level) in the region in question, and a dot (·) indicates, that the species has been found only in a few places close to the boundary of the region to which it belongs, or that it has, on the whole, been found so scantily that no opinion can be formed with regard to its distribution within the different altitudinal regions.

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions.

	Up to 300 m.	300—600 m.	Above 600 m.		Up to 300 m.	300—600 m.	Above 600 m.
Hepaticæ.				<i>Alicularia scalaris</i>	+	+	—
<i>Sauteria alpina</i>	·	·	·	— <i>geoscypha</i>	+	+	+
<i>Reboulia hemisphærica</i>	+	·	·	<i>Eucalyx subellipticus</i>	+	·	·
<i>Fimbriaria pilosa</i>	·	·	·	<i>Haplozia crenulata</i>	+	·	·
<i>Fegatella conica</i>	+	·	·	— <i>sphærocarpa</i>	·	·	·
<i>Preissia commutata</i>	+	·	·	— <i>cordifolia</i>	+	—	·
<i>Marchantia polymorpha</i>	+	—	·	— <i>riparia</i>	+	·	·
<i>Aneura multifida</i>	+	·	·	— <i>atrovirens</i>	+	—	·
— <i>latifrons</i>	+	·	·	— <i>pumila</i>	·	·	·
<i>Pellia Neesiana</i>	+	·	·	<i>Jamesoniella autumnalis</i>	·	·	·
<i>Metzgeria furcata</i>	+	·	·	<i>Sphenolobus minutus</i>	·	·	·
<i>Blasia pusilla</i>	+	·	·	— <i>politus</i>	·	·	·
<i>Fossombronia Dumortieri</i>	·	·	·	<i>Lophozia quinqueidentata</i> ..	+	+	+
<i>Gymnomitrium coralloides</i> ..	+	—	·	— <i>lycopodioides</i> ..	+	—	·
— <i>concinatum</i> ..	—	+	+	— <i>Flørckei</i>	+	+	·
— <i>varians</i>	·	·	·	— <i>quadriloba</i>	+	+	·
— <i>revolutum</i> ..	·	·	·	— <i>Kunzeana</i>	+	+	—
<i>Marsupella Funckii</i>	·	·	·	— <i>barbata</i>	+	·	·
— <i>emarginata</i>	·	·	·	— <i>ventricosa</i>	+	+	+
— <i>aquatica</i>	·	·	·	— <i>Wenzelii</i>	+	·	·
				— <i>alpestris</i>	+	+	+

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions (continued).

	Up to 300 m.	300—600 m.	Above 600 m.		Up to 300 m.	300—600 m.	Above 600 m.
<i>Lophozia excisa</i>	.			<i>Frullania Tamarisci</i>	+		
— <i>Schultzii</i>	+			— <i>fragilifolia</i>	+		
— <i>Mülleri</i>	+	—		<i>Madotheca Cordæana</i>	+		
— <i>Hornschuchiana</i> ..	+	—		<i>Lejeunea cavifolia</i> ..	+		
— <i>heterocolpos</i>	+	—					
<i>Gymnocolea inflata</i>	.			Sphagnales.			
<i>Plagiochila asplenoides</i> ..	+	—	.	<i>Sphagnum medium</i>	+		
<i>Leptoscyphus anomalus</i> ..	.			— <i>papillosum</i> ..	+		
<i>Lophocolea cuspidata</i>	+			— <i>inundatum</i>	+		
— <i>minor</i>	+			— <i>Gravetii</i>	.		
<i>Chiloscyphus polyanthus</i> ..	+	.		— <i>compactum</i>	.		
<i>Harpanthus Flotowianus</i> ..	+			— <i>teres</i>	+	+	
<i>Cephalozia bicuspidata</i>	+	—		— <i>squarrosum</i>	+		
— <i>ambigua</i>	.			— <i>fimbriatum</i>	+	—	
— <i>pleniceps</i>	+	—		— <i>Girgensohnii</i>	+	—	
— <i>media</i>	.			— <i>Russowii</i> ..	.		
<i>Pleuroclada albescens</i>		—	+	— <i>Warnstorffii</i>	+	—	
— <i>var. islandica</i> ..	+			— <i>rubellum</i>	+	—	
<i>Cephaloziella Hampeana</i> ..	+	—		— <i>acutifolium</i>	+		
— <i>rubella</i>	+	—		— <i>subnitens</i>	+		
<i>Odontoschisma elongatum</i> ..	+	.		— <i>Lindbergii</i>	.		
— <i>denudatum</i> ..	.			— <i>riparium</i>	+		
— <i>Macouni</i>	+			— <i>angustifolium</i> ..	.		
<i>Lepidozia setacea</i>							
<i>Blepharostoma trichophyllum</i>	+	+		Musci veri.			
<i>Anthelia julacea</i>	+	—		<i>Andreæa petrophila</i>	+	+	+
— <i>Juratzkana</i>	—	+	+	<i>Gymnostomum rupestre</i> ..	+		
<i>Ptilidium ciliare</i>	+	—	.	<i>Hymenostylium curvirostre</i> ..	+		
<i>Diplophyllum albicans</i>	+			<i>Anœctangium compactum</i> ..	+		
— <i>obtusifolium</i> ..	.			<i>Weisia crispata</i>	+		
<i>Scapania subalpina</i>	+	.		— <i>viridula</i>	+		
— <i>remota</i>	.			— <i>Wimmeriana</i>	.		
— <i>irrigua</i>	+	—	.	<i>Dicranoweisia crispula</i>	+	+	+
— <i>uliginosa</i>	+	—		— <i>compacta</i>	.		
— <i>paludosa</i>	+			<i>Cynodontium polycarpum</i> ..	.		
— <i>dentata</i>	+	.		<i>Dichodontium pellucidum</i> ..	+	—	
— <i>undulata</i>	+	—		<i>Aongstroemia longipes</i>	+	+	
— <i>curta</i>	+	—	.	<i>Oncophorus virens</i>	+	+	—
— <i>Bartlingii</i>	.			— <i>Wahlenbergii</i> ..	+	+	—
<i>Radula complanata</i>	+			<i>Dicranella squarrosa</i>	+	+	
<i>Frullania dilatata</i>	.			— <i>Schreberi</i>	+		

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions (continued).

	Up to 300 m.	300—600 m.	Above 600 m.		Up to 300 m.	300—600 m.	Above 600 m.
<i>Dicranella crispata</i>	+			<i>Tortella fragilis</i>	+		—
— <i>cerviculata</i>	+			<i>Barbula unguiculata</i>	+		
— <i>subulata</i>	+			— <i>fallax</i>	+		
<i>Dicranum fulvellum</i>		+		— <i>cylindrica</i>	+		
— <i>Andersonii</i>	+			— <i>icmadophila</i>	+		
— <i>falcatum</i>		—	+	<i>Desmatodon latifolius</i>	+		—
— <i>Blyttii</i>		+	+	— <i>cernuus</i>			
— <i>Starckeii</i>		+	+	<i>Tortula obtusifolia</i>			
— <i>molle</i>	—	+	—	— <i>muralis</i>	+		
— <i>Bonjeani</i>	+			— <i>subulata</i>	+		
— <i>angustum</i>	+	—		— <i>mucronifolia</i>	+		
— <i>majus</i>	+			— <i>ruralis</i>	+		—
— <i>scoparium</i>	+	—		— <i>aciphylla</i>			
— <i>fuscescens</i>	+	—		<i>Schistidium maritimum</i>	+		
— <i>congestum</i>	+	+	—	— <i>apocarpum</i>	+	+	
— <i>spadiceum</i>	+			— <i>gracile</i>	+	+	—
— <i>elongatum</i>	+			— <i>confertum</i>	+		
<i>Campylopus Schimperi</i>	+			— <i>alpicola</i>			
<i>Trematodon ambiguus</i>	+			— <i>v. rivularis</i>	+		
<i>Fissidens bryoides</i>	+			<i>Grimmia commutata</i>			
— <i>osmundoides</i>	+			— <i>Doniana</i>	+		—
— <i>decipiens</i>				— <i>alpestris</i>	+		
— <i>adanthoides</i>	+			— <i>ovata</i>	+		
<i>Blindia acuta</i>	+	—		— <i>incurva</i>			
<i>Ceratodon purpureus</i>	+	+	—	— <i>patens</i>	+		
<i>Ditrichum tortile</i>	+			— <i>funalis</i>	+		—
— <i>nivale</i>				— <i>torquata</i>	+		
— <i>homomallum</i>	+			<i>Rhacomitrium sudeticum</i>	+	+	—
— <i>flexicaule</i>	+	+		— <i>heterostichum</i>	+	—	
<i>Selania cressia</i>	+			— <i>microcarpum</i>			
<i>Distichium montanum</i>	+	+		— <i>canescens</i>	+	+	+
— <i>inclinatum</i>	+			— <i>hypnoides</i>	+	+	+
<i>Bryoxiphium norvegicum</i>	+			— <i>fasciculare</i>	+	+	+
<i>Pottia Heimii</i>	+			— <i>aciculare</i>	+		
— <i>latifolia</i>				<i>Hedwigia albicans</i>	+		
<i>Didymodon rubellus</i>	+	—		<i>Amphidium lapponicum</i>	+		
— <i>rufus</i>	+			— <i>Mougeottii</i>	+		
<i>Leptodontium flexifolium</i>				<i>Ulota phyllantha</i>	+		
<i>Trichostomum littorale</i>				<i>Orthotrichum anomalum</i>	+		
<i>Tortella inclinata</i>				— <i>saxatile</i>	+		
— <i>tortuosa</i>	+	—		— <i>cupulatum</i>	+		

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions (continued).

	Up to 300 m.	300—600 m.	Above 600 m.		Up to 300 m.	300—600 m.	Above 600 m.
<i>Orthotrichum rupestre</i>	+	.		<i>Bryum uliginosum</i>	+		
— <i>Sturmii</i>	+			— <i>fallax</i>	.		
— <i>Killiasii</i>	+			— <i>œneum</i>	+	—	
— <i>Blyttii</i>	+			— <i>binum</i>	.		
— <i>laevigatum</i>	.	.		— <i>affine</i>	+		
<i>Encalypta ciliata</i>	+			— <i>cirratum</i>	+		
— <i>rhabdocarpa</i>	.	—		— <i>intermedium</i>	+		
— <i>contorta</i>	.			— <i>pallescens</i>	+		
<i>Dissodon splachnoides</i>	+	+		— <i>subrotundum</i>	.		
<i>Tetraplodon bryoides</i>	+			— <i>capillare</i>	+		
<i>Splachnum sphaericum</i>	+	.		— <i>cæspiticiu</i>	+		
— <i>vasculosum</i>	.	+	.	— <i>comense</i>	.		
<i>Funaria hygrometrica</i>	+			— <i>elegans</i>	+	—	
<i>Leptobryum pyriforme</i>	+			— <i>argenteum</i>	+		
<i>Anomobryum filiforme</i>	+			— <i>neodamense</i>	.		
— <i>concinnum</i>	.			— <i>Duvalii</i>	+	.	
<i>Plagiobryum Zierii</i>	+			— <i>pallens</i>	+	.	
— <i>demissum</i>	.			— <i>ventricosum</i>	.	+	.
<i>Pohlia acuminata</i>	+			— <i>arcticum</i>	+		
— <i>polymorpha</i>	.	.		— <i>pendulum</i>	+		
— <i>cruda</i>	+	+	—	— <i>Brownii</i>	.		
— <i>nutans</i>	+	—		<i>Mnium hornum</i>	+		
— <i>cucullata</i>	.	+	+	— <i>orthorrhynchum</i>	+	—	
— <i>Ludwigii</i>	.	+	+	— <i>serratum</i>	+		
— <i>commutata</i>	—	+	+	— <i>spinosum</i>	+		
— <i>gracilis</i>	—	+	+	— <i>undulatum</i>	+		
— <i>Rothii</i>	+			— <i>cuspidatum</i>	+		
— <i>tenuifolia</i>	+			— <i>medium</i>	+		
— <i>grandiflora</i>	+			— <i>affine</i>	+	—	
— <i>proliger</i>	.			— <i>Seligeri</i>	+		
<i>Mniobryum albicans</i>	+	+	+	— <i>stellare</i>	+		
<i>Bryum purpurascens</i>	+	.		— <i>cinclidioides</i>	+	—	
— <i>lacustre</i>	+			— <i>punctatum</i>	+	—	
— <i>Kaurini</i>	.			— <i>subglobosum</i>	+		
— <i>archangelicum</i>	+			<i>Cinclidium stygium</i>	+	+	
— <i>Jørgensenii</i>	.			<i>Paludella squarrosa</i>	+	—	
— <i>inclinatum</i>	+			<i>Amblyodon dealbatus</i>	.		
— <i>retusum</i>	+			<i>Meesa trichoides</i>	+	—	
— <i>islandicum</i>	.			— <i>triquetra</i>	+		
— <i>Grœnlundii</i>	.			<i>Catoscopium nigratum</i>	+	.	
— <i>calophyllum</i>	.			<i>Conostomum boreale</i>	—	+	+

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions (continued).

	Up to 300 m.	300—600 m.	Above 600 m.		Up to 300 m.	300—600 m.	Above 600 m.
<i>Aulacomnium palustre</i>	+	+	.	<i>Pterigynandrum filiforme</i> ...	+	.	.
— <i>turgidum</i>	+	+	.	<i>Lescuræa decipiens</i>	.	.	.
<i>Bartramia ityphylla</i>	+	+	—	— <i>radicosa</i>	.	.	.
<i>Plagiopus Oederi</i>	.	.	.	— <i>filamentosa</i>	+	—	.
<i>Philonotis fontana</i>	+	+	+	— <i>Breidlereri</i>	.	+	—
— <i>Arnellii</i>	.	.	.	— <i>patens</i>	+	—	.
— <i>seriata</i>	+	+	.	<i>Heterocladium squarrosulum</i>	+	.	.
— <i>tomentella</i>	+	+	.	<i>Thuidium tamariscinum</i> ...	+	.	.
<i>Timmia norvegica</i>	+	.	.	— <i>delicatum</i>	+	.	.
— <i>austriaca</i>	+	—	.	— <i>Philiberti</i>	+	.	.
<i>Catharina undulata</i>	+	.	.	— <i>abietinum</i>	+	.	.
<i>Oligotrichum hercynicum</i> ..	.	+	+	— <i>lanatum</i>	+	—	.
<i>Psilopilum lævigatum</i>	+	.	.	<i>Orthothecium rufescens</i>	.	.	.
<i>Pogonatum polytrichoides</i> ..	+	.	.	— <i>intricatum</i>	+	.	.
— <i>dentatum</i> var. <i>minus</i>	.	.	.	— <i>chryseum</i>	+	—	.
— <i>urnigerum</i>	+	.	.	<i>Cylindrothecium concinnum</i> ..	.	.	.
<i>Polytrichum alpinum</i>	+	+	—	<i>Climacium dendroides</i>	+	.	.
— <i>formosum</i>	.	.	.	<i>Isothecium myurum</i>	+	.	.
— <i>gracile</i>	+	.	.	— <i>tenuinerve</i>	+	.	.
— <i>sexangulare</i>	.	—	+	<i>Homalothecium sericeum</i> ...	+	—	.
— —	.	.	.	<i>Camptothecium lutescens</i> ...	+	.	.
— <i>var. tenellum</i>	+	.	.	— <i>nitens</i>	+	+	.
— <i>piliferum</i>	+	.	.	<i>Brachythecium Mildeanum</i> ..	+	.	.
— <i>juniperinum</i> ...	+	—	.	— <i>salebrosum</i> ...	+	—	.
— <i>strictum</i>	+	—	.	— <i>collinum</i> ...	.	.	.
— <i>commune</i>	+	—	.	— <i>populeum</i> ...	+	.	.
— <i>Swartzii</i>	+	.	.	— <i>velutinum</i> ...	+	.	.
<i>Diphyscium sessile</i>	+	+	.	— <i>glaciale</i>	.	+	+
<i>Fontinalis antipyretica</i>	+	—	.	— <i>reflexum</i>	—	+	—
— <i>islandica</i>	.	.	.	— <i>longipilum</i> ...	.	.	.
— <i>longifolia</i>	.	.	.	— <i>glareosum</i> ...	+	.	.
— <i>thulensis</i>	.	.	.	— <i>albicans</i>	+	—	.
— <i>androgyna</i>	.	.	.	— <i>erythrorrhizon</i> ...	+	.	.
<i>Leucodon sciurioides</i>	+	.	.	— <i>rivulare</i>	+	—	.
<i>Antitrichia curtipendula</i> ...	+	.	.	— <i>latifolium</i> ...	.	.	.
<i>Neckera complanata</i>	+	.	.	<i>Scleropodium purum</i>	+	.	.
<i>Myurella julacea</i>	+	.	.	<i>Eurhynchium strigosum</i> ...	+	.	.
— <i>tenerima</i>	+	.	.	— <i>diversifolium</i> ...	.	.	.
<i>Leskea nervosa</i>	+	.	.	— <i>cirrosom</i>	+	.	.
— <i>catenulata</i>	.	.	.	— <i>piliferum</i>	+	.	.
<i>Anomodon viticulosus</i>	+	.	.	— <i>Swartzii</i>	+	.	.

Table III. The Distribution of the Bryophyta in the different Altitudinal Regions (continued).

	Up to 300 m.	300—600 m.	Above 600 m.		Up to 300 m.	300—600 m.	Above 600 m.
Eurhynchium Stockesii	+			Hypnum filicinum	+	—	
Rhynchostegium murale	+			— curvicaule	—	+	
— rusciforme	+			— decipiens	+	—	
Thamnum alopecurum	+			— commutatum	+		
Plagiothecium silvaticum	+			— v. fal-			
— Røseanum	+			— catum	+		
— denticulatum	+			— molluscum	+		
— pulchellum	+			— imponens	+		
— depressum	+			— Bambergeri	—		
— elegans				— revolutum	+	—	
Amblystegium Sprucei	+	—		— cupressiforme	+		
— fluviatile				— hamulosum	+	—	
— serpens	+			— callichroum	+		
— Juratzkanum	+			— Lindbergii	+	—	
— littorale	+			— palustre	+		
— compactum	+			— arcticum			
— salinum	+			— alpestre	+		
— trichopodium	+			— alpinum	+		
Hypnum Sommerfeltii				— ochraceum	+		
— chrysophyllum	+			— cordifolium	+		
— protensum	+			— Richardsonii	+	—	
— stellatum	+	+	—	— giganteum	+	—	
— polygamum	+			— stramineum	+	+	—
— intermedium	+	+		— sarmentosum	+	+	—
— revolvens	+	+		— trifarium	+		
— uncinatum	+	+	—	— turgescens	+	—	
— Sendtneri				Acrocladium cuspidatum	+		
— Kneiffii	+			Scorpidium scorpioides	+		
— exannulatum	+	+		Hylocomium proliferum	+	+	—
— var. pur-				— pyrenaicum			
— purascens	+	+		— parietinum	+		
— var. Rotæ	+			— loreum	+		
— var. ser-				— triquetrum	+		
— ratum				— squarrosum	+	—	
— fluitans	+			— rugosum	+		
— v. falcatum							

Table I shows that of the 424 species enumerated in it (the habitat of *Sphenobolus saxicola* is not known) 416 occur in the low land, and that only 8 species (*Gymnomitrium varians*, *Pleuroclada*

albescens, *Scapania remota*, *Ditrichum nivale*, *Pohlia polymorpha*, *P. Ludwigii* and *Brachythecium glaciale*) have not been found below the upper limit of the birch.

In the Mountain region the number of species is as follows: —

42	Hepaticæ
5	Sphagna
134	Musci veri
—	
181	Total species.

Of these, however, 10 Hepaticæ and 31 Musci veri have been found only in the lowest part, at the boundary towards the Low-land region, whereby the number of species which in reality belong to the Mountain region, is reduced to 140. Of these, 2 Hepaticæ, viz. *Gymnomitrium varians* and *Scapania remota* and 3 Musci veri, viz. *Ditrichum nivale*, *Pohlia polymorpha* and *P. Ludwigii* have been found only in this region.

In the Snow region the number of species is as follows: —
16 Hepaticæ, 42 Musci veri, total 58, of which, 6 Hepaticæ and 10 Musci have been found only in a few localities and cannot be regarded as belonging to this region. In all, 42 species remain, of which, however, only 8 Hepaticæ and 20 Musci veri are fairly frequent, while the others have been found only in a few localities. The majority of the species belong to those which are of equal frequency at all altitudes, and only 4 species (*Pleuroclada albescens*, *Dicranum falcatum*, *Pohlia cucullata* and *Polytrichum sexangulare*) can be designated true Snow-region species.

The number of species decreases rapidly as the height above sea-level increases, and even at the upper limit of the heather moor the number falls to about 40 % of the total number of species. Above a height of about 600 metres the number scarcely reaches 15 % of all the species.

V. THE HORIZONTAL DISTRIBUTION OF THE SPECIES.

IN order to obtain a correct notion of the importance of each plant-species within a floral district it is necessary to know not only their distribution in the different parts of this district, but also their relative abundance (number of individuals) in comparison with other species. The following Table gives a summary of all the Bryophyta found in Iceland, with the exception of the species growing in warm soil, since, as regards these species, it is chiefly the heat of the soil and not the climatic conditions which determine their distribution. The frequency within the different districts is indicated by the figures 1—4, so that 1 indicates rare or very scantily occurring species; 2 those that occur here and there or only in a comparatively few localities and not in abundance; 3 frequent, but as a rule playing no important part in the moss-covering, or occurring only locally in abundance; and 4 the common and abundantly occurring species.

The majority of the species are not equally distributed in all the different altitudinal regions, and the frequency is therefore reckoned relatively to the region in which each species is most widely distributed. As regards species which grow only in quite definite areas (for instance littoral species) the frequency is reckoned separately.

The figures in the table are, however, in many cases somewhat doubtful, since many districts are too superficially investigated to allow one to form an opinion as to the frequency of the less commonly occurring species. This is the case, for instance, as regards the majority of the districts of East Iceland situated above an altitude of 300 metres, because in June, when I travelled through this part of the country, the mountains were still for a great part snow-covered, which in connection with continual fog made investigation almost impossible.

It must also be noted that the table is based only on the

coastal districts, and on the low land with the neighbouring heights. The high land of the interior, which is about 90,000 km². in dimension and, usually, 600—1000 metres in height, is from a botanical point of view practically unknown. Outside the Jökulls it consists almost everywhere of gravelly flats which are practically bare of vegetation. According to Thoroddsen, however, there are in some places extensive mountain-bogs, but the Bryophyte vegetation of these is quite unknown.

Table IV. The Frequency of the Species in the different Districts of Iceland.

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
	Hepaticæ.					
a	<i>Sauteria alpina</i>		1*			
m	<i>Reboulia hemisphærica</i>					3*
a	<i>Fimbriaria pilosa</i>		1*	1*		
m	<i>Fegatella conica</i>					4
u	<i>Preissia commutata</i>		2*	1	2	3*
u	<i>Marchantia polymorpha</i>	4*	4*	4*	4*	4*
u	<i>Aneura pinguis</i>	4	4	4*	4	4*
m	— <i>multifida</i>					1
u	— <i>latifrons</i>		1	1	1	
u	<i>Pellia Neesiana</i>	4	4*	4	4	4
m	<i>Metzgeria furcata</i>	3	3	3	3	4
u	<i>Blasia pusilla</i>		2		1	
m	<i>Fossombronina Dumortieri</i>					1
a	<i>Gymnomitrium corallioides</i>	3	2		3	2
a	— <i>concinatum</i>	4*	4*	4*	4*	4*
a	— <i>varians</i>		1	1		
a	— <i>revolutum</i>			1		
u	<i>Marsupella emarginata</i>			1		2
u	— <i>aquatica</i>			1		
m	— <i>Funckii</i>	1				1
u	<i>Alicularia scalaris</i>	4*	4*	4*	4*	4*
b	— <i>geoscypha</i>	4*	4*	4*	4*	4*
a	<i>Eucalyx subellipticus</i>	2*	1*	2*	1*	1*
b	<i>Haplozia sphærocarpa</i>			1		
a	— <i>cordifolia</i>	4*	4*	4*	4*	4*
b	— <i>riparia</i>					3*
a	— <i>atrovirens</i>	3*	3*	3*	3*	3*
b	— <i>pumila</i>		1*			
m	— <i>crenulata</i>			1	1	
m	<i>Jamesoniella autumnalis</i>					1

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
u	<i>Sphenolobus minutus</i>	1		1	1	
b	— <i>saxicola</i> ?.....					
a	— <i>politus</i>			1*		
u	<i>Lophozia quinquedentata</i>	4	4*	4*	4	4
b	— <i>lycopodioides</i>	4	4	4	4	3
b	— <i>Flærckei</i>			4	2	
a	— <i>quadriloba</i>	3	2	2	2	2
b	— <i>Kunzeana</i>	4	4	4	4	4
m	— <i>barbata</i>	1			2	1
u	— <i>ventricosa</i>	3	3	4*	3	3
a	— <i>Wenzelii</i>	1	1*	1*	1	
a	— <i>alpestris</i>	4	4	4*	4*	4*
m	— <i>excisa</i>					1*
b	— <i>Schultzii</i>	1	1		1*	
u	— <i>Mülleri</i>	3	3	3	3	3
a	— <i>Hornschuchiana</i>	2	1*	1	2	
b	— <i>heterocolpos</i>		1	1	1	1
u	<i>Gymnocolea inflata</i>			1		
u	<i>Plagiochila asplenoides</i>	4	4	4	4	4
u	<i>Leptoscyphus anomalus</i>	1				
m	<i>Lophocolea cuspidata</i>					2
m	— <i>minor</i>		1			1
b	<i>Chiloscyphus polyanthus</i>	4	4	4	4	4
b	<i>Harpanthus Flotowianus</i>	1	1	4	2	
u	<i>Cephalozia bicuspidata</i>	4*	4*	4*	4*	4*
a	— <i>ambigua</i>			1*		
b	— <i>pleniceps</i>	3*	3*	4*	3*	?
b	— <i>media</i>		1*	1*		
a	<i>Pleuroclada albescent</i>	3	3	4	2	
a	— — <i>var. islandica</i> ...		1			2
u	<i>Cephalozia Hampeana</i>	4*	4*	4*	4*	4*
u	— <i>rubella</i>	1	1	2	1	1
u	<i>Odontoschisma elongatum</i>	2	1		3	1
u	— <i>denudatum</i>				1	
a	— <i>Macouni</i>	1	1		1	
m	<i>Lepidozia setacea</i>					1
u	<i>Blepharostoma trichophyllum</i>	4	4*	4	4	4*
b	<i>Chandonanthus setiformis</i> ?.....					
a	<i>Anthelia julacea</i>	3*	3*	3*	3*	3*
a	— <i>Juratzkana</i>	4*	4*	4*	4*	4*
u	<i>Ptilidium ciliare</i>	4	4	4	4	4
u	<i>Diplophyllum albicans</i>				3	3
m	— <i>obtusifolium</i>	1	1			

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
a	<i>Scapania subalpina</i>	4*	4*	4*	4*	4*
a	— <i>remota</i>		1			
b	— <i>irrigua</i>	4?	4*	4	4	4*
b	— <i>uliginosa</i>	1		3		
b	— <i>paludosa</i>			3*		
u	— <i>dentata</i>	3*	1*		2*	3*
u	— <i>undulata</i>	4*	4*	4*	4*	4*
b	— <i>curta</i>	4*	4*	4*	4*	4*
a	— <i>Bartlingii</i>					1
m	<i>Radula complanata</i>	3	1*		3	3*
m	<i>Madotheca Cordæana</i>	2		2	3	4
u	<i>Frullania dilatata</i>				1	
u	— <i>Tamarisci</i>	4	4	4	4	4
m	— <i>fragilifolia</i>				1	1
m	<i>Lejeunea cavifolia</i>				1	3
Sphagnales.						
b	<i>Sphagnum medium</i>			1	1	2
m	— <i>papillosum</i>				2	2
u	— <i>inundatum</i>				1	1
u	— <i>Gravetii</i>			1		
b	— <i>compactum</i>					1
u	— <i>teres</i>	4	4	4	4	4
u	— <i>squarrosum</i>		1	3		
u	— <i>fimbriatum</i>		2	2	3	1
n	— <i>Girgensohnii</i>	3	3	3	3	3
b	— <i>Russowii</i>					1
u	— <i>Warnstorffii</i>	3	3	3	3	3
u	— <i>rubellum</i>	3	3	3	3	3
u	— <i>acutifolium</i>		1	1	1	1
u	— <i>subnitens</i>			1	2	2
b	— <i>Lindbergii</i>				1	
u	— <i>riparium</i>			3		
m	— <i>angustifolium</i>		1			
Musci veri.						
b	<i>Andræa petrophila</i>	4*	4*	4*	4*	4*
u	<i>Gymnostomum rupestre</i>	1	3		3	3
b	<i>Hymenostylium curvirostre</i>		1		1	3*
u	<i>Anæctangium compactum</i>	4			3	4
m	<i>Weisia crispata</i>				1	1*
m	— <i>viridula</i>					1*
a	— <i>Wimmeriana</i>		1*			

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
a	<i>Dicranoweisia crispula</i>	4*	4*	4*	4*	4*
a	— <i>compacta</i>		1			
u	<i>Cynodontium polycarpon</i>	1*				
b	<i>Dichodontium pellucidum</i>	4*	4*	4*	4*	4*
a	<i>Aongstrœmia longipes</i>	3	3*	1	2	2
b	<i>Oncophorus Wahlenbergii</i>	4*	4*	4*	4*	4*
b	— <i>virens</i>	4*	4*	4*	4*	4*
b	<i>Dicranella squarrosa</i>	2	3*	4	2	1
u	— <i>Schreberi</i>		1		1	
b	— <i>crispa</i>	4*	4*	4*	4*	4*
b	— <i>subulata</i>		1	1		1
u	— <i>cerviculata</i>			2	2	1
a	<i>Dicranum fulvellum</i>					3*
a	— <i>Andersonii</i>	1*				3*
a	— <i>falcatum</i>	2*	2*	3*	2*	3*
b	— <i>Blyttii</i>	1*	1*	3*	3*	3*
a	— <i>Starckeii</i>	4*	4*	4*	4*	4*
a	— <i>molle</i>	1*	1*	4*	3*	1*
m	— <i>Bonjeani</i>	1	1		2	
b	— <i>angustum</i>	3	1	1	2	1
u	— <i>majus</i>			3	1	
u	— <i>scoparium</i>	4	4	4*	4*	3*
u	— <i>fuscescens</i>			4*	1	
u	— <i>congestum</i>	4	4	?	3	2
a	— <i>spadiceum</i>	2	1		1	
a	— <i>elongatum</i>		2	2	2	
a	<i>Campylopus Schimperi</i>	1	1		2	1
m	<i>Trematodon ambiguus</i>				1	
m	<i>Fissidens bryoides</i>		1*			1*
b	— <i>osmundoides</i>	3	3	3	3*	3
u	— <i>adanthoides</i>		1*		2*	
u	— <i>decipiens</i>				1	
b	<i>Blindia acuta</i>	4*	4*	4*	4*	4*
u	<i>Ceratodon purpureus</i>	2*	3*	3*	3*	2*
u	<i>Ditrichum tortile</i>	1				
a	— <i>nivale</i>	1				
u	— <i>homomallum</i>	1	1		2*	1
u	— <i>flexicaule</i>	4*	4	4	4	4
a	<i>Sælania cæsia</i>	2*	2*		3*	2*
b	<i>Distichium montanum</i>	4*	4*	4*	4*	4*
u	— <i>inclinatum</i>	1*	2*	1*		
a	<i>Bryoxiphium norvegicum</i>					3
u	<i>Pottia Heimii</i>	2*	3*	1*	3*	3*

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
a	<i>Pottia latifolia</i>		1*			
u	<i>Didymodon rubellus</i>	4*	4*	4*	4*	4*
b	— <i>rufus</i>	1	1		1	
m	<i>Leptodontium flexifolium</i>		1			
m	<i>Trichostomum littorale</i>				1	1
u	<i>Tortella inclinata</i>	1				
u	— <i>tortuosa</i>	4	4	4	4	4
b	— <i>fragilis</i>	3	3	3	3	3
m	<i>Barbula unguiculata</i> var. <i>cuspidata</i> ..				1	1
m	— <i>fallax</i>				1	1
m	— <i>cylindrica</i>		1		1	3*
a	— <i>icmadophila</i>	1	1		1	
a	<i>Desmatodon latifolius</i>	3*	2*	3*	2*	
a	— <i>cernuus</i>		1*			
a	<i>Tortula obtusifolia</i>					1*
m	— <i>muralis</i>					1*
u	— <i>subulata</i>	3*	3*	3*	3*	3*
m	— <i>mucronifolia</i>					1*
u	— <i>ruralis</i>	2*	3*	3*	2	2
a	— <i>aciphylla</i>			1*		
u	<i>Schistidium maritimum</i>	3*	3*	3*	3*	3*
u	— <i>apocarpum</i>	3*	3*	3*	3*	3*
u	— <i>gracile</i>	4*	4*	4*	4*	4*
b	— <i>confertum</i>	1*	2*			
a	— <i>alpicola</i>		1*			
a	— — var. <i>rivularis</i>	4*	4*	4*	4*	3*
b	<i>Grimmia commutata</i>		1		1	
a	— <i>Doniana</i>	3*	2*	2*	3*	3*
a	— <i>alpestris</i> ..	1				1*
b	— <i>ovata</i>	2	2			
a	— <i>incurva</i>	1				
u	— <i>patens</i>	1			1	
a	— <i>funalis</i>	4*	4*	4*	4*	4*
b	— <i>torquata</i>	2	1	2	3	4
b	<i>Rhacomitrium sudeticum</i>	4*	3*	4*	3*	3*
b	— <i>microcarpum</i>		1			
u	— <i>heterostichum</i>	3	2	2	4	4
u	— <i>canescens</i>	4*	4	4*	4	4
u	— <i>hypnoides</i>	4	4	4	4	4
b	— <i>fasciculare</i>	4*	3*	3*	4*	4*
m	— <i>aciculare</i>	4*	4*	4*	4*	4*
m	<i>Hedwigia albicans</i>					1
b	<i>Amphidium lapponicum</i>	4*	4*	4*	4*	4*

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
u	<i>Amphidium Mougeottii</i>	3	2	3	4	4
u	<i>Ulotia phyllantha</i>	3	3	3	3	3
m	<i>Orthotrichum anomalum</i>					1*
m	— <i>saxatile</i>					1*
m	— <i>cupulatum</i>					1*
u	— <i>rupestre</i>	3*	3*	3*	3*	3*
u	— <i>Sturmii</i>	1*			1*	
a	— <i>Killiasii</i>	1*	1*		?	
a	— <i>Blyttii</i>	2*	1*	1*	1*	
a	— <i>lævigatum</i>		2*	1*	1*	
b	<i>Encalypta ciliata</i>	3*	2*		3*	3*
u	— <i>rhabdocarpa</i>	3*	3*	3*	3*	3*
u	— <i>contorta</i>				1	
b	<i>Dissodon splachnoides</i>	1*	4*	3*	1*	1*
a	<i>Tetraplodon bryoides</i>	2*	2*	2*	2*	2*
b	<i>Splachnum sphericum</i>	3*	3*	2*	2*	2*
b	— <i>vasculosum</i>	3*	3*	3*	3*	3*
u	<i>Funaria hygrometrica</i>	3*	3*	3*	3*	3*
u	<i>Leptobryum pyriforme</i>	4*	4*	2*	3*	4*
a	<i>Anomobryum filiforme</i>	2		1	2	3*
a	— <i>concinnum</i>					1
b	<i>Plagiobryum Zierii</i>	2	1	1	2	2*
a	— <i>demissum</i>				1*	
a	<i>Pohlia acuminata</i>				1*	2*
a	— <i>polymorpha</i>				1	
u	— <i>cruda</i>	4*	4*	4*	4*	4*
u	— <i>nutans</i>	1*	1*	3*	1*	2*
a	— <i>cucullata</i>		1*	2*		
a	— <i>Ludwigii</i>		1*			
a	— <i>commutata</i>	4*	4*	4*	4*	4*
b	— <i>gracilis</i>	4*	4*	4*	4*	4*
b	— <i>Rothii</i>		1			
b	— <i>tenuifolia</i>	2	2		1	
b	— <i>proligera</i>		1			
b	— <i>grandiflora</i>					2
b	<i>Mniobryum albicans</i>	4*	4*	4*	4	4*
b	<i>Bryum purpurascens</i>	2*	3*	2*	2*	1
b	— <i>lacustre</i>	2*	3*	1*	2*	2*
a	— <i>Kaurini</i>	1*				
a	— <i>archangelicum</i>			1*	1*	1*
u	— <i>inclinatum</i>	4*	4*	4*	4*	4*
a	— <i>retusum</i>		2*	1*		
Icel.	— <i>islandicum</i>		1*			

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
b	<i>Bryum calophyllum</i>	1*				
u	— <i>uliginosum</i>		2*		1*	
Icel.	— <i>Groenlundii</i>				1*	
b	— <i>fallax</i>		1*			
a	— <i>œneum</i>	2	1	1	1*	3*
m	— <i>bimum</i>	1*				
b	— <i>affine</i>	3*	3*	3*	3*	3*
b	— <i>cirratum</i>	2*	2*	3*	2*	1*
u	— <i>intermedium</i>		1*			1*
b	— <i>pallescens</i>	3*	3*	3*	3*	4*
a	— <i>subrotundum</i>					1*
u	— <i>capillare</i>	1	1		1	2*
u	— <i>cœspiticium</i>	2*	2*			1*
a	— <i>comense</i>		1			
u	— <i>argentum</i>	3	3	3	3	3
a	— <i>neodamense</i> var. <i>ovatum</i>	1				
b	— <i>Duvalii</i>	4*	4*	4	4	4
u	— <i>pallens</i>	3	3	3	3*	4*
u	— <i>ventricosum</i>	4*	4*	4*	4*	4*
a	— <i>arcticum</i>	3*	3*	3*	3*	2*
u	— <i>pendulum</i>		1*		1*	2*
a	— <i>Brownii</i>		1*		1*	
a	— <i>Jørgensenii</i>					1*
m	<i>Mnium hornum</i>	3	2	3	3	4
a	— <i>orthorrhynchum</i>	4	4	4	4	4
m	— <i>serratum</i>		1*		2*	3*
u	— <i>spinosum</i>		1			
m	— <i>undulatum</i>					3
m	— <i>cuspidatum</i>		1			1
b	— <i>medium</i>	1				
u	— <i>affine</i>	4	4	4	4	4
u	— <i>Seligeri</i>	3	2		2	4
m	— <i>stellare</i>	1	1*		1	1
b	— <i>cinclidiodides</i>	4	4	4	4	4
u	— <i>punctatum</i>	4*	4*	4*	4*	4*
b	— <i>subglobosum</i>		2*		1*	1
b	<i>Cinclidium stygium</i>	4*	4*	3*	3*	3*
b	<i>Paludella squarrosa</i>	4	4	3	3	2
b	<i>Amblyodon dealbatus</i>		1*			
b	<i>Meesea trichoides</i>	4*	4*	4*	4*	4*
u	— <i>triquetra</i>	3	3	2	2	2
b	<i>Catoscopium nigrum</i>	4*	4*	2*	4*	2*
a	<i>Conostomum boreale</i>	3*	3*	4*	3*	3*

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
u	<i>Aulacomnium palustre</i>	4	4	4	4	4
a	— <i>turgidum</i>	2	2	2	1	1
u	<i>Bartramia ityphylla</i>	4*	4*	4*	4*	4*
b	<i>Plagiopus Oederi</i>	1*	1*			
u	<i>Philonotis fontana</i>	4*	4*	4*	4*	4*
b	— <i>Arnellii</i>		1		1	1
a	— <i>seriata</i>	2	3*	4*	2	1
b	— <i>tomentella</i>	4*	4*	4*	4*	4*
a	<i>Timmia norvegica</i>	1	1			1
b	— <i>austriaca</i>	4	4*	2	4	4
m	<i>Catharina undulata</i>	2*	1*		3*	4*
a	<i>Oligotrichum hercynicum</i>	2*	2*	4*	2*	3*
a	<i>Psilopilum lævigatum</i>	3*	3*	3*	3*	3*
m	<i>Pogonatum polytrichoides</i>				2*	2*
a	— <i>dentatum</i> var. <i>minus</i>				1*	
u	— <i>urnigerum</i>	3*	3*	3*	3*	3*
a	<i>Polytrichum alpinum</i>	4*	4*	4*	4*	4*
m	— <i>formosum</i>				1	
b	— <i>gracile</i>	3*	3*	3*	3*	3*
a	— <i>sexangulare</i>	?	3*	4*	3*	3*
u	— <i>piliferum</i>	1*	2*	2*	2*	2*
u	— <i>juniperinum</i>	3*	3*	3*	3*	3*
b	— <i>strictum</i>	2	3	3	2	2
u	— <i>commune</i>	2	2	2	2*	2
b	— <i>Swartzii</i>			1		
b	— — var. <i>nigrescens</i> ..			1		
u	<i>Diphyscium sessile</i>	3	1*	2	3*	3*
u	<i>Fontinalis antipyretica</i>	3	3	3	3	3
Icel.	— <i>islandica</i>	1				
Icel.	— <i>longifolia</i>					2*
Icel.	— <i>thulensis</i>					1
b	— <i>androgyna</i>				1*	1*
m	<i>Leucodon sciuroides</i>	1			1	2*
u	<i>Antitrichia curtipendula</i>	2	2	2	3	3
m	<i>Neckera complanata</i>				1	2
b	<i>Myurella julacea</i>	4	4	4	4	4
b	— <i>apiculata</i>	3	3	3	3	2
b	<i>Leskea nervosa</i>	1				1
u	— <i>catenulata</i>			1		
m	<i>Anomodon viticulosus</i>					1
u	<i>Pterigynandrum filiforme</i>	4	4	4	4	4
a	<i>Lescuræa decipiens</i>	1		1		
a	— <i>radicosa</i>		1			

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
b	<i>Lescuræa filamentosa</i>	3	3	4*	3	3
a	— <i>Breidlerii</i>	1	2	3		1
b	— <i>patens</i>	1	1*	2*	2	1
b	<i>Heterocladium squarrosulum</i>	1	1		1	1
m	<i>Thuidium tamariscinum</i>					3
m	— <i>delicatulum</i>			1	2	3
m	— <i>Philiberti</i>				1	3
b	— <i>lanatum</i>	4*	4*	2*	2*	1*
a	<i>Orthothecium rufescens</i>				1	
a	— <i>intricatum</i>		1			2
a	— <i>chryseum</i>	4	4	2	2	
m	<i>Cylindrothecium concinnum</i>		1			1
u	<i>Climacium dendroides</i>	4*	4	4	4	4
m	<i>Isothecium myurum</i>				1	2
b	— <i>tenuinerve</i>	1		1	3	3
u	<i>Homalothecium sericeum</i>	4	4	4	4	4*
m	<i>Camptothecium lutescens</i>	2	2	2	3	3
b	— <i>nitens</i>	4*	4*	4*	4*	3*
u	<i>Brachythecium Mildeanum</i>	1			1	
u	— <i>salebrosum</i>	2	2	2	2	2*
a	— <i>collinum</i>				1	
Icel.	— <i>longifolium</i> ..					1*
u	— <i>populeum</i>					1*
u	— <i>velutinum</i>					2*
a	— <i>glaciale</i>		1	1	1	
b	— <i>reflexum</i>	3*	3*	3*	3*	3*
u	— <i>glareosum</i>	1	1		1	
u	— <i>albicans</i>	3	3	3	3	3
b	— <i>erythrorrhizon</i>		1		1	
b	— <i>rivulare</i>	4	4	4	4	4
b	— <i>latifolium</i>		1			
m	<i>Scleropodium purum</i>					3
m	<i>Eurhynchium strigosum</i>				1	
m	— — <i>var. præcox</i> ..		1		1	1
a	— <i>diversifolium</i>		1			
a	— <i>cirrosum</i>				1	
m	— <i>piliferum</i>				2	3
m	— <i>Swartzii</i>					3
m	— <i>Stockesii</i>					2
m	<i>Rhynchostegium murale</i>					1*
m	— <i>rusciforme</i>		1	1	2	3*
b	— — <i>v. atlanticum</i>		2		1	2
m	<i>Thamnium alopecurum</i>				1	3

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
u	<i>Plagiothecium silvaticum</i>		1			1
u	— <i>Roeseanum</i>	3	3	3	3	3
u	— <i>denticulatum</i>		2	1	1	1
b	— <i>pulchellum</i>	3*	3*	3*	3*	3*
m	— <i>depressum</i>					1
m	— <i>elegans</i>					1
a	<i>Amblystegium Sprucei</i>	3	3	3	3	3
m	— <i>fluviatile</i>					1
m	— <i>serpens</i>		1*	1*		1*
m	— <i>Juratzkanum</i>		1*			1*
b	— <i>littorale</i>		1		1	
b	— <i>compactum</i>				1	1
b	— <i>salinum</i>					1
m	— <i>trichopodium</i>		1			
m	<i>Hypnum Sommerfeltii</i>		1			1
u	— <i>chrysophyllum</i>	1	1		1	1
u	— <i>protensum</i>	2	1		2	
u	— <i>stellatum</i>	4*	4*	4*	4*	4*
b	— <i>polygamum</i>	4*	4*	3*	4*	3*
u	— <i>intermedium</i>	?	3	?	?	?
b	— <i>revolvens</i>	4*	4*	4*	4*	4*
u	— <i>uncinatum</i>	4*	4*	4*	4*	4*
m	— <i>Sendtneri</i>		1			
b	— <i>Kneiffii</i>	3	3*	2	2	2
u	— <i>exannulatum</i>	4*	4*	4*	4*	3*
a	— var. <i>Rotæ</i>	2		1	1	
u	— <i>fluitans</i>		1			1
a	— var. <i>falcatum</i>			2*		
u	— <i>filicinum</i>	4*	3*	4*	4*	4*
a	— <i>curvicaule</i>	2*			1	
b	— <i>decipiens</i>	4	4*		1	
m	— <i>commutatum</i>	2	2	2	2	3*
b	— <i>falcatum</i>	4*	4*	4	4	4*
m	— <i>molluscum</i>	1			3	4*
b	— <i>imponens</i>	1			1	
a	— <i>Bambergeri</i>				1	
a	— <i>revolutum</i>	4	4	4	4	4*
u	— <i>cupressiforme</i>	2	2		3	4*
a	— <i>hamulosum</i>	1		1	2	2
a	— <i>callichroum</i>	1		3*	2	3
u	— <i>Lindbergii</i>	4	4	4	4	4
u	— <i>palustre</i>	1*	2*		2*	3*
a	— <i>arcticum</i>			1*	1*	

Table IV. The Frequency of the Species in the different Districts of Iceland (continued).

		E. Icel.	N. Icel.	NW. Icel.	W. Icel.	S. Icel.
a	<i>Hypnum alpestre</i>	3*	3*	3*	2*	2*
a	— <i>alpinum</i>	1*	3*	3*		
a	— <i>ochraceum</i>	4	4	4	4	4
u	— <i>cordifolium</i>		1	1*		
b	— <i>Richardsonii</i>	2*	2*	1	1	1
b	— <i>giganteum</i>	4*	4*	4*	4*	4*
u	— <i>stramineum</i>	4	4*	4	4	4
a	— <i>sarmentosum</i>	3	3*	3*	3	3
b	— <i>trifarium</i>	1	1			
a	— <i>turgescens</i>	1	1			1
u	<i>Acrocladium cuspidatum</i>	4*	4*	4*	4*	4*
u	<i>Scorpidium scorpioides</i>	4	4	4	4	3
u	<i>Hylocomium proliferum</i>	4	4	4	4	4
b	— <i>pyrenaicum</i>					1
u	— <i>parietinum</i>	2		3	3	3
u	— <i>loreum</i>			2	3	3*
u	— <i>triquetrum</i>	2	1	2	3	3
u	— <i>squarrosum</i>	4	4	4	4	4
b	— <i>rugosum</i>	3	3	3	3	3

Of the 93 Hepaticæ, 20 Sphagna and 326 Musci veri found in Iceland, 7 Hepaticæ, 3 Sphagna and 4 Musci veri (besides 3 varieties) have been found only on warm soil. The other 425 species (87 Hepaticæ, 17 Sphagna and 322 Musci veri) enumerated in the above table can be arranged according to frequency in the following groups (Table V): —

- Dominant or very common species, the frequency of which is expressed by the figure 4 in all parts of Iceland or by 3 in only a few parts.
- Frequent species, the frequency of which is expressed by the figure 3 in the whole, or at any rate in the greater part, of Iceland.
- Species of which the frequency is expressed by the figures 1 à 2, or which have a higher degree of frequency only in a single district of Iceland.

Table V.

	Group a	Group b	Group c
Hepaticæ	23	14	49
Sphagna	1	3	13
Musci veri.....	64	82	176
Total...	88	99	238
	20.7 %	23.5 %	55.8 %

Iceland, according to the climatic conditions, may be divided into 5 districts, which division, also as regards the Land vegetation, coincides well with that employed by Helgi Jónsson (1912, p. 5) for the Marine vegetation along the coasts.

East Iceland, from Eystri Horn in the South-east to Langanes in the North-east.

North Iceland, from Langanes to Cape Horn in the North-west.

North-west Iceland, from Cape Horn to Látrabjarg.

West Iceland, from Látrabjarg to Reykjanes.

South Iceland, from the western point of the peninsula of Reykjanes to Eystri Horn.

The boundary lines between these districts are in most places formed by ridges or high-lying mountain plateaus. In the South-east, Lónsheidi (height about 400 metres) and Hofsjökul form the boundary between South and East Iceland. West Iceland is separated from South Iceland by the mountain-chain which stretches throughout the peninsula of Reykjanes, the lofty mountain of Hengill, the lake of Thingvall and the mountains situated north of a line drawn from Thingvellir to Geysir. Between North and East Iceland there is no sharp boundary line, either as regards climate or geography. South-east Iceland (from Seydisfjörður southwards) has a very damp climate with many foggy days (near Berufjörður on an average 171 annually), while the western part of North Iceland (the districts about Eyjafjörður, Skagafjörður and Hunaflói) has a greater difference between the summer and the winter temperature, considerably less precipitation and comparatively few foggy days. North-west Iceland, which comprises the country around the deep, narrow

fjords which open out towards the north-west, lies rather isolated, separated as it is from North and West Iceland by Jökulls and lofty mountain-ridges. The boundary between North and West Iceland is rather undefined. Several species which are common in West Iceland, but rare in or absent from North Iceland, are met with right in around Hunaflói. Here the range of hills east of Blóndudalur appears to form a natural boundary, since *Camptothecium lutescens* and *Racomitrium heterostichum*, for instance, have not been found east of this line, whilst other species common in North Iceland, for instance *Orthothecium chryseum*, *Hypnum decipiens* and *Thuidium lanatum*, are rare west of it.

Of the 87 Hepaticæ, 17 Sphagna and 322 Musci veri enumerated in Table II, 30 Hepaticæ, 4 Sphagna and 108 Musci veri (or collectively 33 %), are almost equally frequent in all the districts of Iceland, the frequency being (with a few exceptions) 3—4. The rest of the species can be grouped as follows:—

1. Species with a mainly Southern distribution.
2. » » » » Northern and Eastern distribution.
3. » » » » Western distribution.
4. Species which occur sporadically in several of the districts of Iceland.

1. Species with a mainly Southern Distribution.

a. Found only in South Iceland (the figure denotes frequency).

Meridional.			
Reboulia hemisphærica	3	Scleropodium purum	3
Fegatella conica	4	Eurhynchium Swartzii	3
Fossombronia Dumortieri	1	— Stockesii	2
Aneura multifida	1	Rhynchostegium murale	1
Jamesoniella autumnalis	1	Plagiothecium elegans	1
Lophozia excisa	1	— depressum	1
Lophocolea cuspidata	1	Boreal.	
Lepidozia setacea	1	Haplozia riparia	3
Weisia viridula	1	Sphagnum compactum	1
Tortula muralis	1	Pohlia grandiflora	2
— mucronifolia	1	Amblystegium salinum	1
Hedwigia albicans	1	Hylocomium pyrenaicum	1
Orthotrichum anomalum	1	Alpine.	
— saxatile	1	Scapania Bartlingii	1
— cupulatum	1	Dicranum fulvellum	3
Mnium undulatum	3	Bryoxiphium norvegicum	3
Anomodon viticulosus	1	Tortula obtusifolia	1
Thuidium tamariscinum	3		

Anomobryum concinnum	1	Icelandic species.
Bryum Jörgensenii	1	Brachythecium longipilum 1
Ubiquists.		Fontinalis thulensis
Brachythecium populeum	1	— longifolia
— velutinum	1	2.

b. Found in South Iceland and in the most nearly adjacent parts of West and East Iceland.

	S.	W.	E.		S.	W.	E.
Meridional.				Hypnum molluscum	4	3	1
Marsupella Funckii	1		1	Thuidium Philiberti	3	1	
Frullania fragilifolia ...	1	1					
Lejeunea serpyllifolia ...	3	1		Boreal.			
Sphagnum papillosum ...	2	2		Fontinalis androgyna	1	1	
Weissia crispata	1	1					
Barbula unguiculata var.				Alpine.			
cuspidata	1	1		Dieranum Andersonii ...	3		1
Trichostomum littorale ..	1	1					
Leucodon sciurioides	2	1		Ubiquists.			
Isoetecium myurum	2	1		Grimmia patens		1	1
Eurhynchium piliferum ..	3	2					

c. Most frequent in South Iceland, rarer in the other districts of Iceland.

	S.	W.	NW.	N.	E.		S.	W.	NW.	N.	E.
Meridional.						Grimmia torquata ...	4	3	2	1	2
Radula complanata .	3	3		1	3	Plagiobryum Zierii ..	2	2	1	1	2
Madotheca Cordæana	4	3		2	2						
Barbula cylindrica ..	3	1		1		Alpine.					
Mnium hornum	4	3	2	2	3	Bryum œneum	3	1	1	1	2
— serratum	3	2		1							
Catharinea undulata .	4	3		1	2						
Neckera complanata .	2	1				Ubiquists.					
Thuidium delicatulum	3	2	1			Sphagnum subnitens .	2	2	1		
Rhynchostegium rus-						Bryum capillare	2	1		1	1
ciforme	3	2	1	1		— pendulum ...	2	1		1	
Thamnium alopecu-						Mnium Seligeri	4	2		2	3
rum	3	1				Antitrichia curtipe-					
Hypnum commutatum	3	2	2	2	2	dula	3	3	2	2	2
Boreal.						Hypnum palustre ...	3	2		2	1
Sphagnum medium ..	2	1	1			— cupressiforme	4	3		2	2
Hymenostylium cur-						Hylocomium loreum .	3	3	2		
virostre	3	1		1		— triquetrum	3	3	2	1	2

2. Species with a mainly Northern Distribution.

With the exception of the southernmost part of East Iceland — almost as far as Djupivogur — and the westernmost part of North Iceland — as far as Blóndudalur — there is a very great

resemblance between the Bryophyte vegetation of East and North Iceland, therefore they will partially be mentioned collectively in the following lists.

a. Found only in North Iceland.

Meridional.		Alpine.	
Sphagnum angustifolium.....	1	Sauteria alpina.....	1
Leptodontium flexifolium	1	Scapania remota.....	1
Amblystegium trichopodium....	1	Weisia Wimmeriana.....	1
		Dicranoweisia compacta	1
		Pottia latifolia	1
		Desmatodon cernuus.....	1
		Bryum comense.....	1
		Pohlia Ludwigii.....	1
		Eurhynchium diversifolium ...	1
		Lescuræa rigescens	1
Boreal.		Icelandic.	
Haplozia pumila.....	1	Bryum islandicum.....	1
Pohlia prolifera.....	1		
— Rothii	1		
Bryum fallax.....	1		
Mnium spinosum.....	1		
Amblyodon dealbatus.....	1		
Brachythecium latifolium	1		

b. Found only in East Iceland.

Meridional.		Bryum neodamense var. ovatum. 1	
Bryum bimum	1	— Kaurini.....	1
		Grimmia incurva	1
Boreal.		Ubiquists.	
Leptoscyphus anomalus	1	Cynodontium polycarpum.....	1
Bryum calophyllum.....	1	Tortella inclinata.....	1
Alpine.		Icelandic.	
Ditrichum nivale	1	Fontinalis islandica	1

c. Found only in North and East Iceland.

Meridional.		N. E.		N. E.	
				Plagiopus Cederi.....	1 1
Diplophyllum obtusifolium ..	1 1			Hypnum trifarium.....	1 1
Boreal.		Alpine.			
Schistidium confertum.....	2 1			Orthotrichum Killiasii	1 1
Grimmia ovata.....	2 2				

d. Most widely distributed in East and North Iceland.

Boreal.		E. N. NW. W. S.		E. N. NW. W. S.	
				Pohlia tenuifolia.....	2 2 1
Dicranum congestum..	4 4 ? 3 2			Bryum purpurascens..	2 3 2 2 1
Distichium inclinatum .	1 2 1			— lacustre.....	2 3 1 2 2
Dissodon splachnoides.	1 4 3 1 1			Paludella squarrosa...	4 4 3 3 2

	E. N. NW. W. S.		E. N. NW. W. S.
Cinclidium stygium ...	4 4 3 3 3	Alpine.	
Thuidium lanatum ...	4 4 2 2 1	Aulacomnium turgidum	2 2 2 1 1
Orthothecium chryseum	4 4 2 2		
Hypnum decipiens ...	4 4 1	Ubiquists.	
— Richardsonii.	2 2 1	Meesea triquetra.....	3 3 2 2 2

3. Species with a mainly Western Distribution.

a. Found only in North-west Iceland.

Boreal.			
Haplozia sphærocarpa.....	1	Tortula aciphylla.....	1
Polytrichum Swartzii.....	1	Hypnum fluitans var. falcatum..	2
— var. nigrescens	1	Ubiquists.	
		Marsupella aquatica.....	1
Alpine.		Gymnocolea inflata.....	1
Gymnomitrium revolutum.....	1	Sphagnum Gravetii.....	1
Sphenolobus politus.....	1	— riparium.....	3
Cephalozia ambigua.....	1	Leskea catenulata.....	1

b. Found only in West Iceland.

Meridional.			
Trematodon ambiguus.....	1	Pohlia polymorpha.....	1
Polytrichum formosum.....	1	Pogonatum dentatum var. minus.	1
Pogonatum polytrichoides.....	2	Ubiquists.	
Alpine.		Fissidens decipiens.....	1
Plagiobryum demissum.....	1	Encalypta contorta.....	1

c. Most widely distributed in North-west Iceland.

Boreal.	E. N. NW. W. S.		E. N. NW. W. S.
Lophozia Flörckei....	4 2	Philonotis seriata.....	2 3 4 2 1
Harpanthus Flotowianus	1 1 4 2	Oligotrichum hercyni-	
Scapania uliginosa ...	1 3	cum	2 2 4 2 3
Dicranella squarrosa ..	2 2 4 2 1	Polytrichum sexangulare	3 2 4 3 3
Bryum cirratum.....	2 2 3 2 1	Lescuræa Breidlerii....	1 2 3 1
Alpine.		Ubiquists.	
Pleuroclada albescens..	3 3 4 2 2	Dicranum majus.....	3 1
Pohlia cucullata.....	1 2	— fuscescens..	4 1
		Pohlia nutans.....	1 1 3 1 2

d. Most widely distributed in the western part of Iceland.

Ubiquists.	E. N. NW. W. S.		E. N. NW. W. S.
Dicranella cerviculata..	1 2 2	Dicranum elongatum..	2 2 2
		Isothecium tenuinerve.	1 3 3
Boreal.			
Dicranum Blyttii	1 1 3 3 3	Meridional.	
		Camptothecium lutescens	2 2 2 3 3
		Barbula fallax.....	1 1

Table VI. Collective Survey of the Number of Species
in the different Districts of Iceland.

Plant-geographical character	m		b		a		u		Number of Species
Frequency	1-2	3-4	1-2	3-4	1-2	3-4	1-2	3-4	
South Iceland.....	39	16	31	41	30	36	23	75	291
Found only in South Iceland	26	9	5	1	4	3	3		51
East Iceland.....	11	4	26	51	32	30	30	68	252
Found only in East Iceland	1		2		4		2		9
North Iceland.....	23	2	33	50	43	30	38	68	287
Found only in North Iceland	3		7		10				20
Found only in N. and E. Iceland	1		4		1				6
North-west Iceland.....	7	3	19	49	27	31	25	61	222
Found only in North-west Iceland			3		5		4	1	13
West Iceland.....	25	8	37	48	30	25	33	76	282
Found only in West Iceland	3				3		2		8

By comparing the Tables and Lists of species contained in the present section it is seen that: —

The Meridional species belong mainly to the southern part of Iceland, in the south-western part of which they arrive at their maximum, both as regards number and frequency, and from thence decrease in number and frequency towards north-west and east. In south-east Iceland there is a tolerably sharp limit for their distribution, whilst a great number of species are to be found — but with decreasing frequency — even throughout the whole of West Iceland. The respective percentages of the entire number of species are as follows: — South Iceland 19 %; East Iceland 6 %; North Iceland 9 %; North-west Iceland 5 % and West Iceland 12 %. A comparatively great number of species have been found in a single locality, or in a few localities, in North Iceland, especially around Eyjafjörður and eastwards in the valleys towards Mývatn, which may probably be due to the higher summer temperature of these districts.

The Boreal Group, over the whole of Iceland — with the exception of South Iceland — constitutes the same percentage of the vegetation (S. Icel. 24 %; E. Icel. 30 %; N. Icel. 29 %; NW. Icel. 31 % and W. Icel. 30 %), and the great majority of the species belong to those which are common everywhere (56 species are common to all the districts of Iceland, with a frequency of 3—4, corresponding to about 60—75 %).

The Alpine Group likewise shows almost the same percentage in all the districts (S. Icel. 23 %; E. Icel. 25 %; N. Icel. 26 %; NW. Icel. 26 % and W. Icel. 20 %) of which about half the number (some 30 species) are common to all the districts.

The Ubiquitous Group comprises chiefly species which have a great distribution in all parts of Iceland (S. Icel. 34 %; E. Icel. 39 %; N. Icel. 38 %; NW. Icel. 39 % and W. Icel. 38 %), 73 of which (67—85 %) are common to all the districts, with a frequency of 3—4.

The composition of the vegetation as regards percentage is thus very nearly the same everywhere as regards the three last groups, whilst, with regard to the meridional species, the country may be divided into a north-eastern and a south-western part.

The North-eastern part comprises East and North Iceland as far as Blóndudalur. The meridional species play a very slight rôle in the vegetation here. Two species only, *Metzgeria furcata* and *Racomitrium aciculare*, are common everywhere in this part, and five species, viz. *Radula complanata*, *Madotheca Cordæana*, *Catharinea undulata*, *Mnium hornum* and *Hypnum commutatum*, are somewhat frequent in East Iceland, but are absent from, or are rare in, North Iceland.

Some few, principally Boreal and Alpine species, are characteristic of North and East Iceland.

Hypnum decipiens is very common from Seydisfjörður to Blóndudalur, but is absent from, or is rare in, the other parts of Iceland.

Orthothecium chryseum is one of the most commonly occurring species in the whole of East and North Iceland, but is absent from South Iceland, and is rather rare west of Hunaflói.

Grimmia ovata has been found only in East and North Iceland. *Philonotis tomentella* is very common in meadow-ground in North and East Iceland, from Seydisfjörður; but is less frequent on damp rocks in other parts of Iceland.

Cinclidium stygium, *Meesea triquetra*, *Paludella squarrosa*, *Thuidium lanatum*, *Hypnum exannulatum*, *H. Richardsonii*, *H. sarmentosum* and *H. alpestre* occur far more abundantly in the northern half of Iceland than in the southern, and are often the most abundant constituents of the vegetation.

Dicranum congestum, which is one of the most commonly occurring species in North and East Iceland and occur there in numerous forms, is far more rare in South and West Iceland, and is evidently absent from North-west Iceland.

A rather considerable number of species, which are most frequent in South and West Iceland, decrease in frequency throughout East Iceland, and are absent from, or are rarer in, North Iceland, for instance *Scapania dentata*, *Anæctangium compactum*, *Grimmia torquata*, *Racomitrium heterostichum*, *R. fasciculare*, *Amphidium Mougeotii*, *Mnium Seligeri*, *Diphyscium sessile*, *Hypnum filicinum*, *H. cupressiforme*, *Hylocomium parietinum* and *H. triquetrum*.

South Iceland. The vegetation is primarily characterized by the presence of numerous meridional species, of which those with a frequency of 3—4 constitute an essential part of the moss-covering.

Fegatella conica and *Reboulia hemisphærica* in company with *Preissia commutata* and *Marchantia polymorpha* form special *Marchantiaceæ*-associations on damp shady tuff-faces. *Lejeunea cavifolia*, *Madotheca Cardæana*, *Barbula cylindrica*, *Mnium serratum*, *M. undulatum*, *Catharinea undulata*, *Thuidium tamariscinum*, *T. delicatulum*, *T. Philibertii*, *Eurhynchium piliferum*, *E. Swartzii*, *Rhynchostegium rusciforme*, *Scleropodium purum*, *Thamnium alopecurum*, *Hypnum molluscum* and *H. commutatum* are the most frequently occurring species in SW. Iceland. Of the boreal Bryophyta *Haplozia riparia*, *Hymenostylium curvirostre*, *Grimmia torquata* and *Plagiobryum Zierii* are most widely distributed in South Iceland; but this is no doubt chiefly due to the fact that a suitable substratum (tuff) abounds.

The Alpine species *Dicranum Andersonii*, *D. fulvellum* and *Bryoxiphium norvegicum* are common in the tuff districts of South Iceland, but have not been found in other parts of the country.

Several ubiquists occur more frequently and abundantly in South Iceland than in the other districts, for instance *Mnium Seligeri*, *Antitrichia curtipendula*, *Hypnum palustre*, *H. cupressiforme*, *Hylocomium loreum*, *H. triquetrum* and *H. parietinum*. These species ascend only exceptionally above the limit of the birch.

The difference in the climate is also apparent from the fact that species, which in North and East Iceland are common as far down as the low land, in South Iceland are first met with in abundance at a higher altitude. This is for instance the case with *Schistidium rivulare*, *Oncophorus Wahlenbergii*, *O. virens* and *Dicranum congestum* which are not common until at a height of 200—300 metres. The Bryophyte vegetation in the higher-lying bogs (200—500 metres) also corresponds closely with the bog vegetation of the lowlands of North and East Iceland, while the bog vegetation of South Iceland differs somewhat considerably in character (p. 561).

North-west Iceland. The Bryophyte vegetation differs in several points from that of the other districts. From a narrow belt of coastal land the country rises abruptly to a height of about 500 metres, so that there is only room for the boggy tracts, so common in the other districts of Iceland, in those valleys which, from the head of the fjords, ascend towards the high land. Here the number of species is essentially smaller than in the other districts of Iceland, since many of the common species, as well as of the rare ones, are absent, on the other hand, however, there are some few species which are widely distributed in North-west Iceland, but are absent from, or rarer in the other districts. This, among others, is the case with regard to several of the species belonging to the heath formation.

Dicranum fuscescens, *D. majus* and *D. molle* are very common in NW. Iceland and, in association with other species (especially Hepaticæ), form *Dicranum* heaths (p. 591): a formation which is otherwise rare in Iceland. *Pohlia nutans* and *Bryum cirratum* are also common, especially in the birch coppices. *Polytrichum piliferum* is tolerably frequent and has been found in fruit in several places.

Lophozia Flærkei is very common as far upwards as about 500 metres above sea-level. It has, however, only been found in a lava-field in SW. Iceland.

There are also several hygrophilous species which are characteristic of NW. Iceland: *Sphagnum squarrosum* is frequent on damp slopes and *S. riparium* is rather common in pools. On inundated ground *Scapania uliginosa*, *S. paludosa*, *Harpanthus Flotowianus* and *Philonotis seriata* are very common and often form — either separately or collectively — the bulk of the vegetation. *Hypnum fluitans* var. *falcatum* occurred abundantly north of Isafjörður.

The rocky flat is very widely extended in NW. Iceland, since it comprises all the flats and plateaus above the mountain slopes, and on the north side of the mountains descends as far downwards as to the sea-level. Several rocky-flat plants are therefore more widely distributed here than in the other districts of Iceland. *Oligotrichum hercynicum*, *Racomitrium sudeticum*, *Conostomum boreale*, *Lescuræa Breidlerii*, *Gymnomitrium concinnatum* and *Pleuroclada albescent* are very common. *Sphenobolus politus*, *Haplozia sphaerocarpa*, *Gymnomitrium revolutum* and *G. varians* have been found only on the rocky flats of NW. Iceland.

Lescuræa filamentosa is very common and found fruiting on detached blocks and on rocks, and *L. patens* is also frequent and likewise sets fruit.

Some few species, which are widely distributed elsewhere in Iceland, are absent here, for instance *Scapania dentata*, *Radula complanata*, *Gymnostomum rupestre*, *Campylopus Schimperii*, *Selania cæsia*, *Mnium Seligeri*, *Hypnum cupressiforme* and *Hypnum palustre*, whilst others are rare, for instance *Preissia commutata*, *Leptobryum pyriforme*, *Catoscopium nigrum*, *Timmia austriaca* and *Hypnum falcatum*. The comparatively abundant occurrence of species of *Sphagnum*, and the lesser frequency of the last-mentioned lime-loving species, appear to indicate that the soil here is less calcareous than in the other districts of Iceland.

The Bryophyte vegetation of NW. Iceland has, on the whole, a more decidedly xerophilous and Arctic character than that of the rest of Iceland.

West Iceland has, with the exception of the southern part as far as Borgarfjörður, been very superficially investigated and, apart from a few scattered collections made by Helgi Jónsson, especially in Búdahraun on Snæfellsnes, and my own collections near Stýkkisholmur, the whole stretch of coast north of Hvalfjörður and around Breidifjörður is, from a bryological point of view, quite unknown.

Several of the species characteristic of South Iceland occur here also, partially decreasing in frequency throughout West Iceland, for instance *Thuidium delicatulum*, *Hylocomium loreum*, *Eurhynchium piliferum* and (in the South-west) *Madotheca Cordæana*. Some species have a decidedly westerly distribution in Iceland, being of almost equal frequency in West and South-west Iceland and a few also in

the North-west, whilst they are absent from, or rare in, the other districts of the country. To this group belong: *Dicranella cerviculata*, *Dicranum Blyttii*, *D. elongatum* (western part of N. Iceland around Hunaflói; NW. and W. Iceland), *Ditrichum homomallum* (common in the South-west), *Isothecium tenuinerve*, *Rhynchostegium rusciforme*, *Hypnum hamulosum* and *Hylocomium parietinum*. Finally, *Diplophyllum albicans* is characteristic of all the lava-fields of West and South-west Iceland.

BIBLIOGRAPHY.

As to the older records respecting the Flora of Iceland (Zoëga, Gliemann, Hooker, Hjaltalin, Vahl, Hornemann, Lindsay, Carroll and others) reference may be made to the full mention of these authors by Grönlund in *Botan. Tidsskr.*, Vol. 4, 1870—71, p. 147 and Vol. 7 (2. R., 3. Bd.), 1873, p. 1.

- Arnell, H. W. (1892), *Lebermoosstudien im nördlichen Norwegen*. Jönköping.
- Arnell, H. W. and Jensen, C. (1907), *Die Moose des Sarekgebietes*. Naturw. Unters. des Sarekgebietes in Schwed.-Lapland, III, Stockholm.
- Braithwaite, The British Moss-Flora. London, vol. I, 1880—1887; vol. II, 1888—1895; vol. III, 1903—09.
- Flora danica. *Icones plantarum in regnis Daniae et Norvegiae nascentium ad illustrandam Floram danicam ediderunt* G. C. Oeder, O. F. Müller, M. Vahl, J. W. Hornemann, S. Drejer, F. M. Liebmann, Joh. Lange, Fasc. 1—50. Hafniae, 1761—1880.
- Grönlund, Chr. (1870—71), *Bidrag til Oplysning om Islands Flora*. Bot. Tidsskr., Bd. 4, pp. 147—172.
- (1873), *Bidrag til Oplysning om Islands Flora*. 2. *Hepaticæ og Musci*. Bot. Tidsskr., Bd. 7, pp. 1—26.
- (1877), *Islandske Naturforhold med særligt Hensyn til Mosvæxtens Betydning for Landskabet*. Tidsskr. for populære Fremst. af Naturvidensk., 5 R., IV, pp. 321—356.
- (1881), *Islands Flora*. Kjøbenhavn.
- (1884), *Karakteristik af Plantevæxten paa Island sammenlignet med Floraen i flere andre Lande*. Den Naturhistoriske Forenings Festskrift, Nr. 1, Kjøbenhavn, pp. 107—145.
- (1885), *Afsluttende Bidrag til Oplysning om Islands Flora*. Musci, Hepaticae, Lichenes. Bot. Tidsskr. XIV, pp. 159—217.
- (1895), *Tillæg til Islands Kryptogamflora, indeholdende Lichenes, Hepaticae og Musci*. Bot. Tidsskr. XX, pp. 90—115.
- Hagen, I. (1899—1901). *Musci Norvegiae Borealis*. Tromsø Museums Aarshefter 21—22.
- *Forarbejder til en norsk Løvmosflora I—XX*. Det Kgl. Norske Videnskabers Selskabs Skrifter, Trondhjem 1908—1915.
- Jensen, C. (1897), *Beretning om en Rejse til Færøerne i 1896*. Bot. Tidsskr. XXI, pp. 157—219.
- (1901), *Bryophyta*. Botany of the Færøes, vol. 1, Copenhagen, pp. 120—197.
- (1915), *Danmarks Mosser*. I. Hepaticales, Anthocerotales, Sphagnales. København og Kristiania.
- Jónsson, Helgi (1895), *Studier over Ost-Islands Vegetation*. Bot. Tidsskr. XX, pp. 17—89.
- (1899), *Floraen paa Snæfellsnes og Omegn*. Bot. Tidsskr. XXII, pp. 169—207.

- Jónsson, Helgi (1900), Vegetationen paa Snæfellsnes. Vidensk. Medd. fra den Naturhist. Forening i Kjøbenhavn, pp. 15—97.
- (1905), Vegetationen i Sydland. Bot. Tidsskr. XXVII, pp. 1—82.
- (1912), The Marine Algal Vegetation. The Botany of Iceland, Part 1, 2. Copenhagen and London.
- Limpricht, K. G., Die Laubmoose in Rabenhorst Kryptogamenflora von Deutschland, Oesterreich und der Schweiz. Leipzig 1890—1904.
- Loeske, Leopold (1905—6), Kritische Bemerkungen über einige Formen von Philonotis. — Hedwigia, Bd. 45, p. 100.
- (1905—6), Kritische Übersicht der europäischen Philonotis-Arten. Hedwigia, Bd. 45, p. 145.
- (1911), Revision einiger Amblystegium aus dem Herbare Limpricht. Ung. botan. Blätter, pp. 272—97.
- Müller, K., Die Lebermoose in Rabenhorsts Kryptogamenflora von Deutschland, Oesterreich und der Schweiz. Leipzig 1909—1915.
- Ostenfeld, C. H. (1899), Skildringer af Vegetationen paa Island. Bot. Tidsskr. XXII, pp. 227—253.
- Stefánsson, St. (1896), Bemærkninger til Chr. Grönlund: Tillæg til Islands Kryptogamflora indeholdende Lichenes, Musci, Hepaticae. Bot. Tidsskr. XX, pp. 399—402.
- Thorodsson, Th. (1914), An Account of the Physical Geography of Iceland, with Special Reference to the Plant-Life. The Botany of Iceland, Part I, 2. Copenhagen and London.
- Warming, Eug. (1884), Om Grönlands Vegetation. Medd. om Grönland, XII, 245 pp.
- (1895), Plantesamfund. Grundtræk af den ökologiske Plantegeografi. Kjøbenhavn.
- Warnstorff, C., Kryptogamenflora der Mark Brandenburg, Bd. I, Moose. 1901—1903.
- Winther (1910), Beiträge zur Kenntniss der *Pohlia commutata*, *P. gracilis*, *P. cucullata* und *P. carinata*. Hedwigia 49, p. 54.

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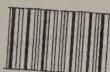
P. 429 l. 7 add Geysir!

- 434 - 1 should read "I. Musci veri".
- 438 - 25 for "elongatum" read "elongatus".
- 463 - 10 from bottom for "Weissia" read "Weisia".
- 471 - 6 for "Wiinsted" read "Wiinstedt".
- 473 - 24 for "*tenuifolia*" read "*grandiflora*".
- 588 - 19 for "Associations" read "Formations".

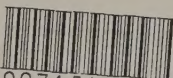
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